POWER PLANT ENGINEERING

Established Over 32 Years

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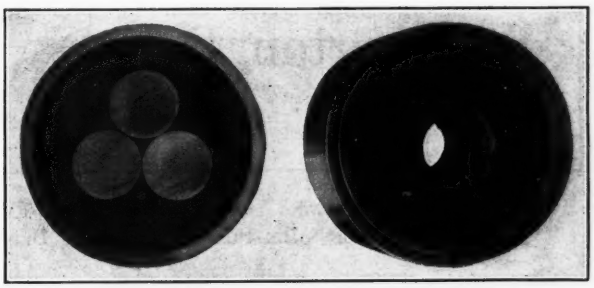


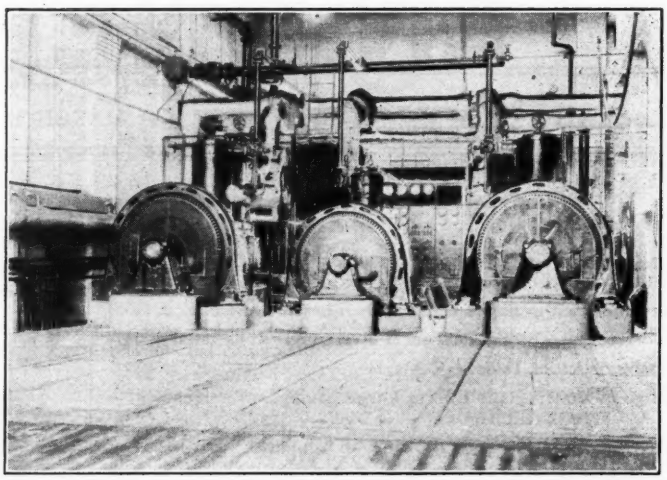
A Hole in One

WE NEVER COULD get it through our heads how it was that electricity could flow through a solid wire or cable. It always seemed that a wire with a hole in it would be much better, and the above picture proves the correctness of our theory. These are two sections of electric power cable for underground transmission. With the exception of the hole through the center of the one at the right both are very much alike. Yet the one with the hole carries 200 times as much electricity as the solid one. The current must flow through the hole!

Depicted side by side as they are above, these cables are close together in space; in time, however, they are a third of a century apart. The cable at the left was installed in 1892, the one at the right in 1927. Despite the similarity in size and appearance the principles involved in their construction, the knowledge underlying their design, and their performance characteristics are vastly different. The Edison tube at the left, of 3,000,000 cir. mil section, was used for 250-v. service and could carry 600 hp. The one at the right is smaller, only 1/5 the size in cir. mils of the older one, yet this 600,000-cir. mil cable for 132,000-v. service is capable of 120,000 hp.! Five hundred, twenty-eight times the voltage and 200 times the power with 1/5 the cross section.

More eloquent than words, these figures bespeak the tremendous progress in cable construction. The thirty-five years of dielectric research are not apparent in the present day cable until its voltage rating and carrying capacity is compared with the old. The oil-filled cable is a section of the 132,000-v. underground transmission line in Chicago, described on page 358 by H. B. Gear.

New Cold Storage Warehouse and Ice Plant at Wilmington, Del.



NEW BUILDING INCORPORATES LATEST FEATURES OF COLD STORAGE WAREHOUSE CONSTRUCTION. ICE PLANT ORIGINALLY DRIVEN BY STEAM NOW OPERATED ELECTRICALLY

SEVERAL YEARS AGO the management of the Diamond Ice and Coal Co. at Wilmington, Del., decided to remodel their 120-ton steam-driven ice plant and change to electric drive. When this change was made they provided sufficient machine capacity to care for the addition of a modern cold storage plant which they saw would be necessary in the city of Wilmington within a few years.

This plant is about 7 yr. old. Originally it was operated by steam using horizontal engine-driven compressors. While these machines operated satisfactorily, about 2 yr. ago, an attractive rate for purchased power was made by the local power company which so appealed to the management that conversion to electric drive was decided upon. All the engine-driven machines were therefore disposed of and an entire new equipment put in, adding, as has been stated, sufficient capacity to take care of cold storage warehouse facilities. Last year saw the fulfillment of the warehouse plan, in the construction of a warehouse having 272,000 cu. ft. of space divided equally among four floors. This building is adjacent to the power plant, the Pennsylvania R. R. and the Wilmington Marine Terminals. It is served by a spur track from the railroad and the design was carefully worked out to allow the loading of freight cars and trucks simultaneously without interference.

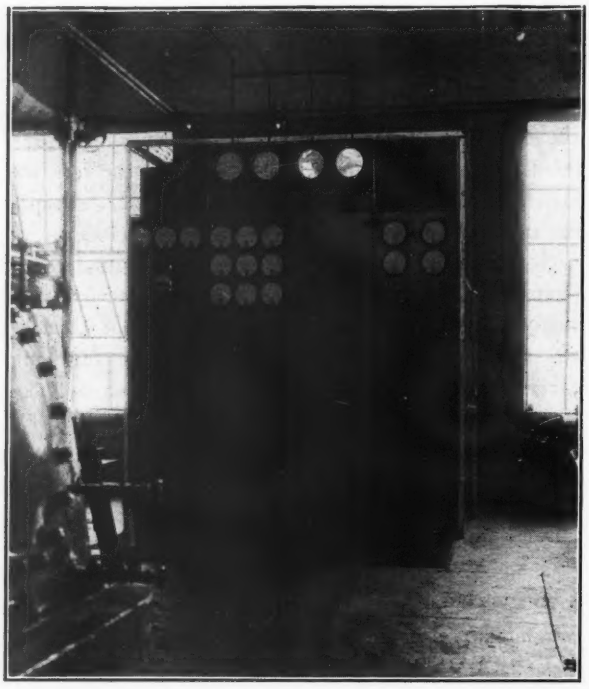


FIG. 1. THIS SWITCHBOARD CONTROLS THE 2200-V. SYNCHRONOUS MOTORS, AND THE EXCITER UNITS

Arrangement of equipment in the power plant is shown in the plan, Fig. 5. The main units are installed in one corner of the room with the ice tanks located on two sides of the building. In the corner of the plant diagonally opposite the compressor machinery is the ice storage room for daily storage, holding about 200 t. In addition to this, a permanent storage house of 12,000 t. capacity is also provided.

Main compressor equipment consists of three vertical, twin-cylinder ammonia machines, set side by side with their shafts parallel to each other and rated as follows:

Two York, vertical, twin-cylinder, 19 by 16-in. units, direct connected to 200-hp., 2200-v., 100 per cent power factor, 3-phase, 60-cycle, Electric Machinery Mfg. Co. synchronous motors designed for operation at 180 r.p.m.

One York, vertical, twin-cylinder, 11 by 13-in. machine, direct connected to a 125-hp. synchronous motor of the same electrical characteristics as those driving the large machines.

In addition to these large compressors, there is also installed a small 2-cylinder York vertical unit, 6 by 6 in., having a capacity of about 25 t. and used for sharp

freezing. This compressor is driven by a 15-hp., 220-v. G. E. induction motor.

Three shell type condensers are provided. These are located as shown and are served with water cooled by a cooling tower on the roof of the power plant. The vertical shell type of condenser was selected because of its simplicity, its compactness and its high efficiency.

Both the direct expansion and brine systems of refrigeration are in use. The basement, first and second floors of the cold storage warehouse are cooled by the brine system while the third floor, which is the sharp freezer, is cooled by direct expansion.

To serve the brine system, there is installed in the basement underneath the compressor floor, a brine cooler and two brine pumps. The liquid receiver and the circulating pumps for the condensers are also located here, these consisting of two units, one of 600 g.p.m. capacity and the other 400 g.p.m.

Synchronous Motor-Driven Compressors Controlled by Push Buttons from Switchboard

The main compressor motors are controlled from a 4-panel switchboard by means of push button control. Since the synchronous motors are 2200-v. machines, it is desirable to protect the operators against accidental contact with live parts. The oil switches, instrument transformers and bus bars associated with the 2200-v. motor circuits, therefore, are all mounted behind the switchboard which is enclosed by grille work.

Figure 1 is a photograph of this control board. From left to right, the panels are as follows:

No. 1. Incoming line meter panel, containing voltmeter, power factor meter, ammeter and an integrating watt-hour meter.

No. 2. Motor control panel for the three large motor circuits. Each circuit is provided with an a.c. ammeter, power factor meter, d.c. ammeter, field rheostat, indicating lamps and start and stop push buttons controlling the main circuit breakers.

No. 3. A feeder panel, controlling the lighting and 220-v. motor circuits.

No. 4. Exciter panel, controlling the exciters for the synchronous motors.

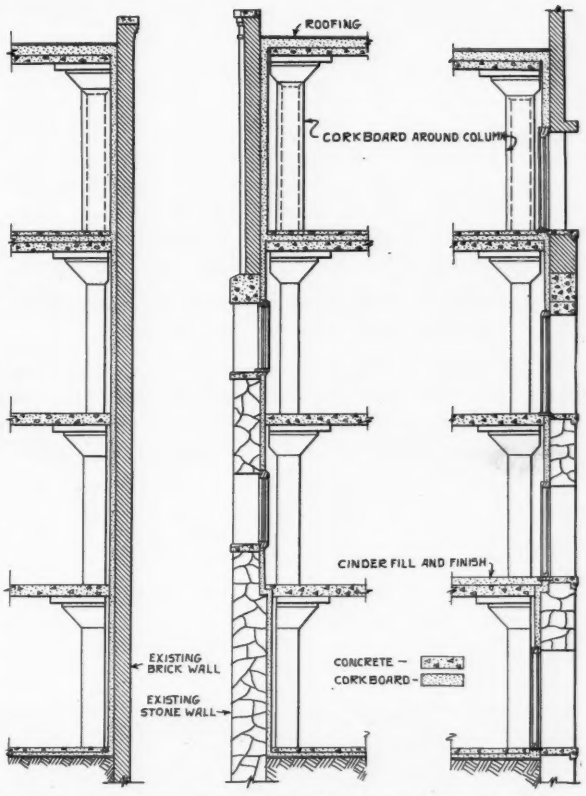


FIG. 2. SECTIONS THROUGH WALLS OF COLD STORAGE PLANT, SHOWING METHOD OF INSULATING

Excitation for the synchronous motors is furnished by two motor-driven exciters. These are Westinghouse units, consisting of a 15-kw., 125-v., 1750-r.p.m., d.c. generator, direct connected to a 25-hp., 220-v. induction motor.

The Ice Tanks

For the manufacture of raw water ice, 20 ice tanks are provided, arranged as indicated in Fig. 2. Eight of these tanks have 66 cans per tank and the remaining 12, 78 cans per tank. They are served by four brine

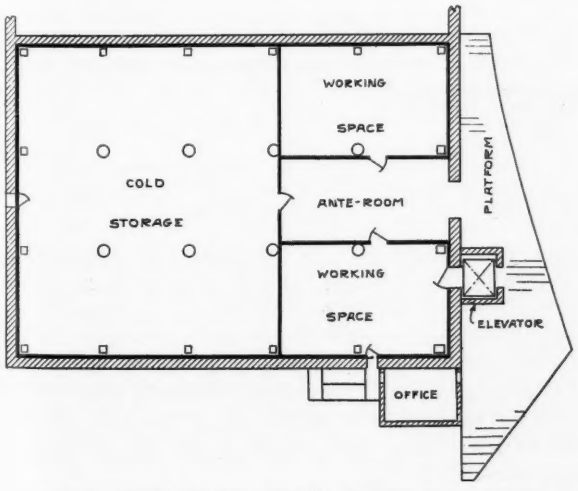


FIG. 3. PLAN OF MAIN FLOOR OF COLD STORAGE WAREHOUSE

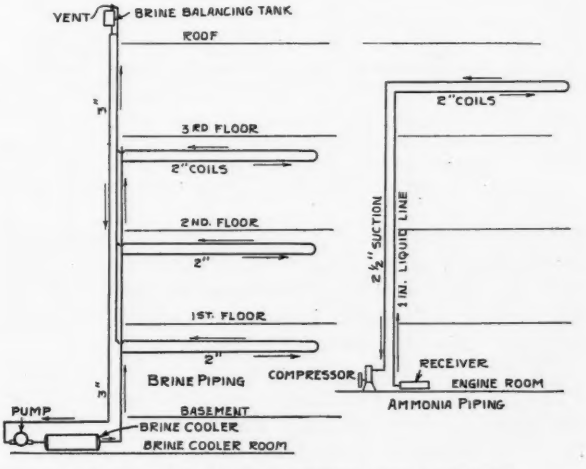


FIG. 4. DIAGRAMS OF BRINE AND AMMONIA PIPING SYSTEMS

coolers, two of which are 46 in. by 12 ft. and two, 30 in. by 12 ft.

Compressed air for agitating the water during the freezing period is furnished by two rotary compressors, supplying air at 3 lb. pressure when operating at 3500 r.p.m. They are driven by 8.5-hp., 220-v. induction motors. The ice tanks are served by 2 cranes operated by compressed air with capacities of about ½ t. each. Compressed air for this service is furnished by two 6 by 5-in. compressors, belt driven by induction motors.

The New Cold Storage Warehouse Embodies Most Modern Principles of Construction

With external walls of brick and stone and floors and roof of concrete slabs, the new building is entirely of fireproof construction. The roof and walls are supported independently of the walls by concrete columns. Each floor has access to a steel fire escape on the outside of the building. To guard further against danger of fire, a modern drip pipe sprinkler system is in use.

Within the building the insulation is of the curtain wall type, forming a continuous envelope and including the basement floor, the walls and roof. No insulation has been employed between the three floors devoted to ordinary cooler goods storage, but the top floor devoted to freezer space has 5 in. of cork insulation placed on top of its floor slab and then a three-inch concrete wearing floor on top of this. The thickness of the insulation on the side walls varies depending upon the exposure of the wall. The roof insulation is very heavy in order to resist the direct action of the sun's rays and to provide for the freezer space which is located on the top floor. In the freezer room, the concrete columns are protected by a heavy cork insulation in order to prevent cold traveling down through the columns and sweating on the ceiling of the rooms below. In the design of the proper thickness of insulation the object was to obtain a minimum even heat loss on all exposed surfaces consistent with economical refrigeration costs.

The interior arrangement of the building has been maintained simply. The basement, second and third floors are without dividing partitions and give in each case a clear floor space the extent of the building, about 98 ft. by 69 ft. On the first floor, there is a large cooler room approximately 57 by 69 ft. and two working rooms for repacking, each measuring about 23 ft. by 38 ft. All of these rooms are insulated. There is also on this floor an unrefrigerated ante-room of the same size as the working rooms. The ceiling height on all floors is approximately 11 ft.

Figure 3 is a plan of the first floor, while Fig. 2 shows sections through some of the walls to indicate the

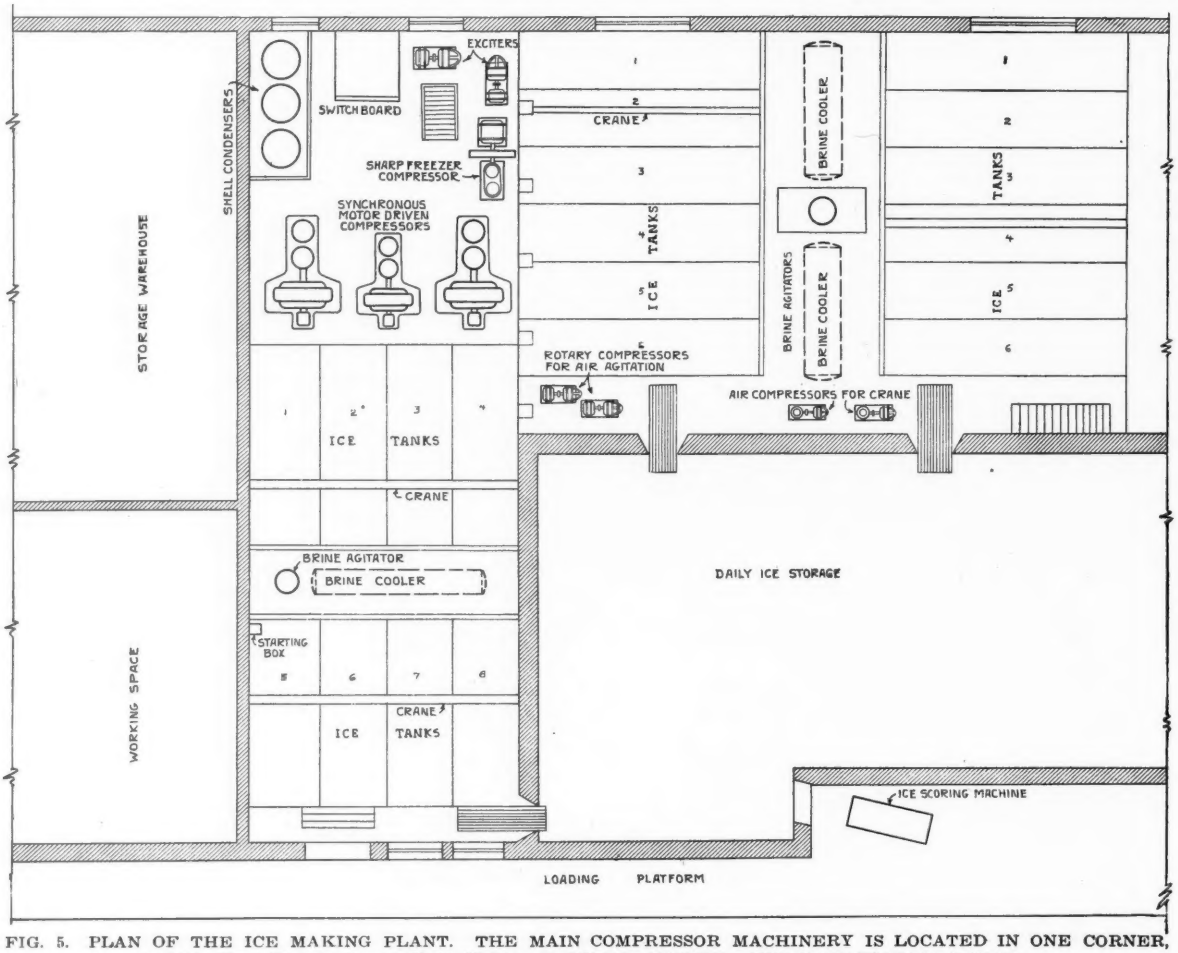


FIG. 5. PLAN OF THE ICE MAKING PLANT. THE MAIN COMPRESSOR MACHINERY IS LOCATED IN ONE CORNER, WITH THE ICE TANKS EXTENDING AT RIGHT ANGLES, THUS FACILITATING PIPING

details of construction. The latter views show the insulating envelope which completely surrounds the cold storage space. From these may also be seen the manner in which the floors are supported on columns independently of the walls. The top floor, it will be noted, has 5 in. of corkboard insulation between the concrete slab forming the floor and the 6-in. concrete wearing surface. Refrigeration for the cooler floors is provided by the use of a brine circulating system and for the freezer floors by direct expansion piping. Each of these floors has installed three banks of 2-in. pipe suspended from the ceiling. The pipes are spaced on 8-in. centers, and each tank is four pipes high by four pipes wide. The banks

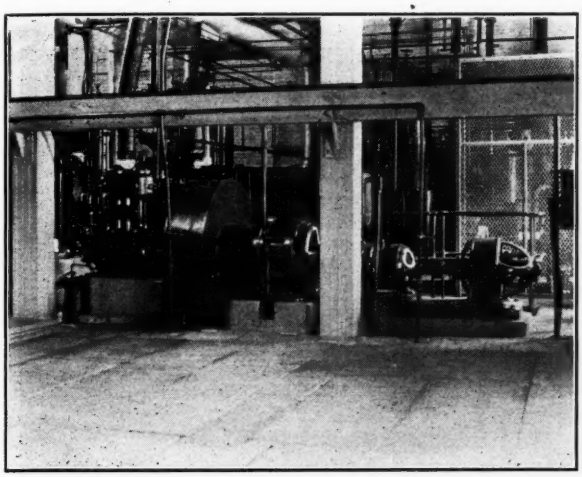


FIG. 6. SHARP FREEZER COMPRESSOR, AT THE LEFT AND ONE OF THE MOTOR DRIVEN EXCITERS

are located in the center of their respective bays. On the freezer floors three banks of 2-in. direct expansion pipe are in use. The banks are six pipes wide and high, with spacing of eight inches on centers. Two expansion valves control the flow of liquid ammonia to each bank. A freezer temperature of 0 deg. F. is being easily maintained and in the cooler rooms the temperature is nicely adjusted to values of from 28 deg. F. to 35 deg. F., as the case may demand.

As explained at the beginning of this article, due to the previous remodeling of the ice plant, very little added machinery equipment was required. A 150-sq. ft. brine cooler was placed in service together with two centrifugal pumps driven by 5-hp. motors. This equipment cared for the cooler rooms. For the freezer rooms there was installed the 6 by 6-in. York compressor directly connected to a 15-hp. motor. Due to the low temperature of the freezers and the consequently low suction pressure, it proved to be a decided advantage to operate this room on a separate compressor instead of attempting to carry the entire plant at the low freezer suction pressure. The power saving on this account during a year's time is considerable. Under normal operation conditions the 6 by 6-in. machine simply serves as a booster to raise the freezer suction pressure which is carried around 0 lb. gage to the ice-making suction pressure carried between 20 and 30 lb. gage.

Temperatures carried on the different floors of the cold storage warehouse vary somewhat according to the character and the requirements of the products carried. For storing vegetables, a temperature of 25 deg. F. is carried in the basement. On the first floor the temperature for eggs is 30 deg., for meat 31-32 deg., and for oranges 34 deg. Frozen fruit, stored on the second floor, is kept at 25 deg. and the sharp freezer which constitutes the third floor, at 0 deg.

The excellent supervision accorded the warehouse and its availability at all times of the day or night has made this business a very popular one in Wilmington.

In concluding this article, we wish to express our indebtedness to the officers and chief engineer of the

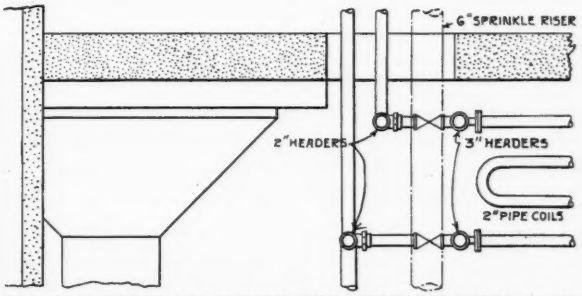


FIG. 7. METHOD OF CONNECTING REFRIGERATING COILS IN WAREHOUSE TO RISERS

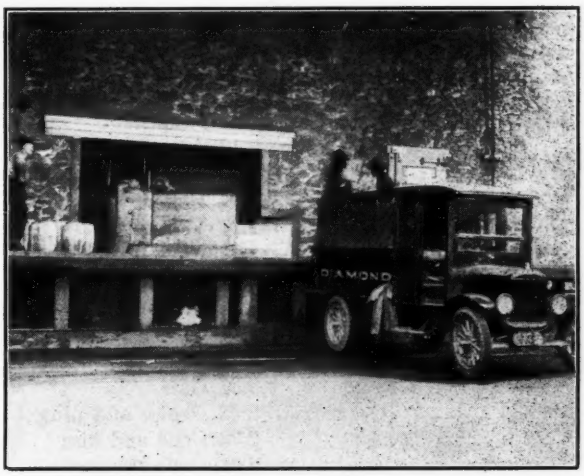


FIG. 8. ALL ICE MADE AT THE PLANT IS SCORED BY A ULINE ICE SCORING MACHINE

Diamond Ice & Coal Co. for courtesies extended in collecting data, and to Ophuls and Hill, Inc., of New York City, who were the consulting engineers and who furnished the drawings.

GEORGE LEE, general counsel of the Iowa-Nebraska Power Co., Lincoln, Nebr., addressing the Des Moines, Iowa, Advertising Club recently, declared the industry's "pitifully and inexcusably weak sales policies, commercial advertising and new business development" constituted the "greatest challenge now confronting newspapermen, advertising men and merchandising experts." The industry, he pointed out, is on the eve of a great commercial awakening and he enumerated the various fields into which it has not fully entered and enjoyed the prosperity to which it is rightfully entitled.

Many Meters Developed to Measure Flow

IN GENERAL, METERS OF THE SAME TYPE HAVE BEEN DEVELOPED TO MEASURE AIR, STEAM, GAS OR WATER, ALTHOUGH THE DETAILS OF THE METER CONSTRUCTION FOR DIFFERENT FLUIDS MAY VARY CONSIDERABLY

MEASUREMENT of air, gas, steam and water quantities presents fundamentally the same problem. From a theoretical standpoint, aerodynamics and hydraulics can be reconciled to the same dimensional analysis. When applied to quantity measurements, however, physical conditions make the practical application of certain meter types simpler for one fluid than for another.

In the past two or three hundred years many different types of meters have been developed. These types have been studied, analyzed and classified by the Research Committee on Fluid Meters of the A. S. M. E. under a decimal classification as follows:

Division	Class	Type
1. Positive	1.1 Weighing	1.11 Weighers
		1.12 Tilting traps
	1.2 Volumetric	1.21 Tank
		1.22 Piston
		1.23 Disc
		1.24 Rotary
		1.25 Bellows
		1.26 Wet drum
2. Inferential	2.1 Current (Kinematic)	2.11 Propeller
		2.12 Anemometer
		2.13 Turbine
		2.14 Helical
	2.2 Head (Dynamic)	2.21 Venturi
		2.22 Flow nozzle
		2.23 Thin plate orifice
		2.24 Pitot tube
		2.25 Centrifugal
		2.26 Friction
	2.3 Area (Geometric)	2.31 Gate
		2.32 Orifice and plug
		2.33 Cone and disc
		2.34 Cylinder and plunger
	2.4 Head area (Weir)	2.41 Square notch
		2.42 Triangular notch
		2.43 Special notch
	2.5 Force	2.51 Hydrometric pendulum
		2.52 Vane
	2.6 Thermal	2.61 Electric

This classification allows the insertion of any new types without interfering in any way with the arrangement or consideration of the older types. But two general classifications are recognized, positive and inferential. In the first the fluid passes through the meter in successive quantities, isolated from the main stream flow by alternately filling and emptying containers of known volume.

In the inferential meter the quantities are not isolated from the main stream but are measured as a continuous flow with the quantity or flow determined not by simple counting, but inferred from the action of the stream on the primary device by known physical laws or empirically determined relations. Meters of the type 1.11 to 2.14, inclusive, give total quantities directly, regardless of the rate of flow, while meters of types 2.21 to 2.61, inclusive, give the rate of flow and when arranged to give total quantities a time element forms part of the secondary device.

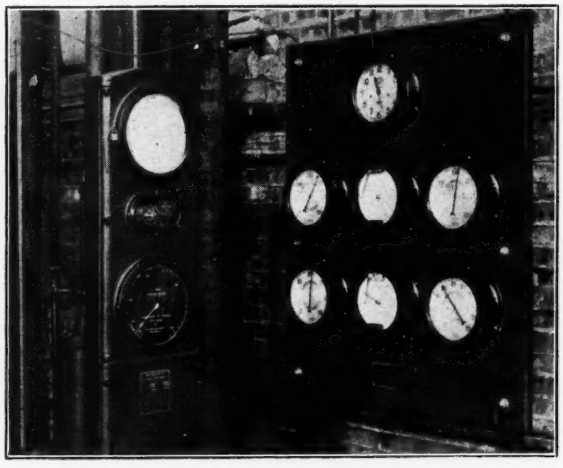


FIG. 3. WELL ARRANGED GROUP OF INSTRUMENTS IN AN INDUSTRIAL PLANT

In fact, most fluid meters consist of two distinct parts, each of which has a function to perform. The first is the primary element which is in contact with the fluid to be measured and is acted upon directly by it. The second is the element which translates the action of the fluid on the primary element into volumes, weights or rate of flow and indicates or records the result.

SOME METERS CAN BE USED FOR ANY FLUID

Some of the meters are adaptable to either gas or liquid measurements while others can be used for gas or liquid only as the case may be. A number of the latter type are illustrated in Fig. 1. Those from 1-a to 1-e, inclusive, represent water meters, while those from 1-f to 1-h, inclusive, are used for gas or air exclusively.

The weighmeter, Fig. 1-e, weighs the water, the exact arrangement of the mechanism depending upon the manufacturer. In some cases the stream is automatically shifted from one tank to the other when a predetermined weight has been reached. While one tank is filling the other discharges, a counter actuated automatically being arranged to record each time the instrument trips. Another type with about the same cycle of operation measures volumes instead of weights. The disc, piston and turbine water meters, Fig. 1-b, 1-d and 1-c are too well known to need detailed mention.

In effect, the piston meter is a small piston pump. In fact, by calculating the displacement and finding the slip, a positive displacement pump can be used to ap-

proximate the capacity discharged by the simple expedient of attaching a counter of some kind to keep track of the revolutions or strokes. With a power pump where the length of the stroke is definitely determined, this method is in many cases quite satisfactory, with a direct-acting pump, however, short stroking is liable to give indications of a higher flow than actually exists.

For measuring gas, the so-called dry or bellows gas meter, using flexible parchment bellows, is of the same general type. The turbine meter is a small water wheel geared to a counter. In fact, in the early days, when many industrial plants used small water wheels and paid for the water used, the water wheels themselves were wet type, Fig. 1-f, is widely used for gas measurements and the anemometer, Fig. 1-g, is in common use for air measurements, especially for ventilating work.

Both Mechanical and Electrical Recorders Available

Meters in Fig. 2 can be and are used for air gas, steam and water measurements. They are all of the so-called inferential type. The Venturi, Fig. 2-a, is one of the oldest meters used for power plant service, and can be equipped with a recording, integrating and indicating mechanism, as shown in the left of Fig. 3. The flow nozzle, Fig. 2-b, and the flat plate or square edge

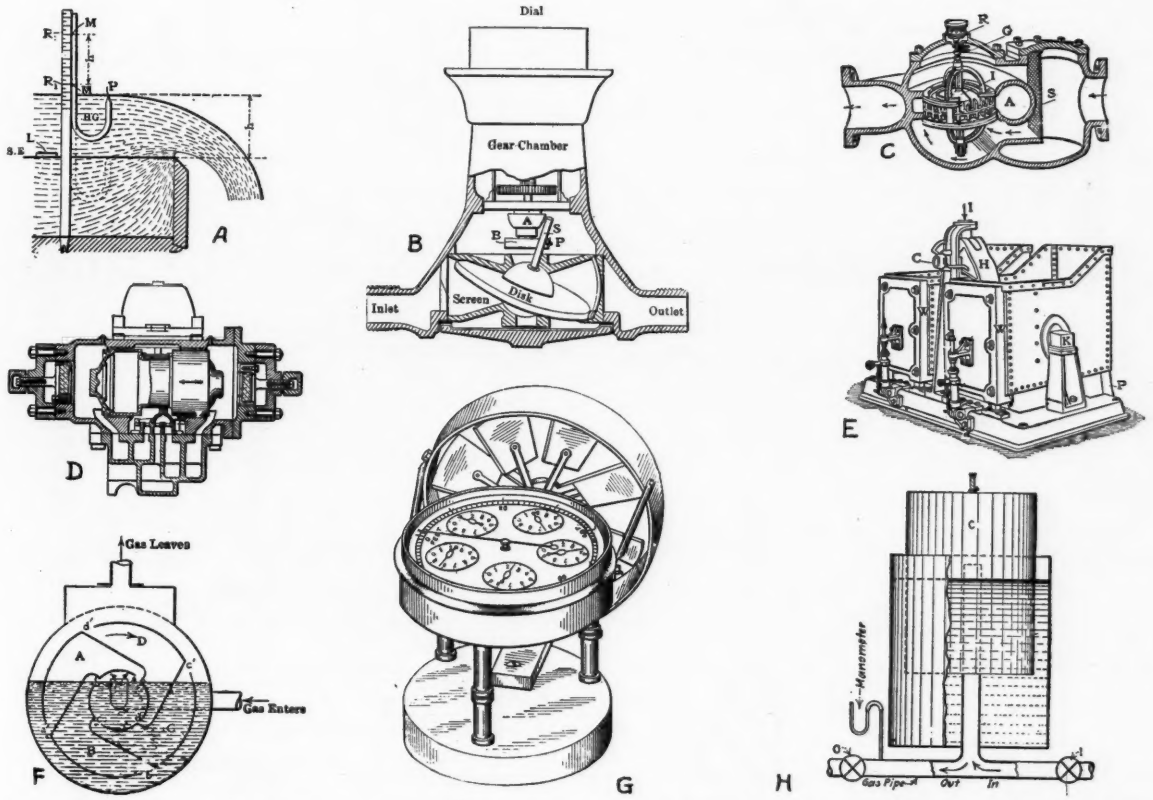


FIG. 1. A. WEIR, B. DISK METER, C. TURBINE METER, D. PISTON METER, E. WEIGH METER, F. WET GAS METER, G. ANEMOMETER, H. GASOMETER

calibrated and payment for water based upon the number of revolutions made by the wheel.

Characteristic curves of centrifugal pumps and fans can be used in the same way to obtain an approximation of the flow. In both of these the quantity discharged bears a definite relation to the head and, if the head can be measured, the quantity being discharged can be found by referring to the test or characteristic curve of the pump or fan.

Many forms of weirs, Fig. 1-a, are in use, the most common in power plant work being the V notch.

Typical gas meters are shown in the lower part of Fig. 1. The gasometer type of gas meter is used to a considerable extent and is shown in Fig. 1-h. The rotary orifice, depend upon the same principle as the Venturi and are extremely popular for power plant work. These meters all depend upon a difference in pressure caused by an increased velocity through a constricted area in the pipe. The secondary device that is the recording, integrating and indicating mechanism, is made in two types, the mechanical and electrical. The former depends upon the direct action of the mercury or other liquid while in the second form the mercury acts simply as a means of controlling the electrical flow in an external circuit, wattmeters and ammeters giving the flow indication. A group of meters of this kind, installed on a central board, are shown in Fig. 4. A portable meter of the flat plate orifice type is shown in Fig. 2-g.

Calibrated nozzles, such as that in Fig. 2-c, are based on the same principle as the flow nozzle and are convenient means of water measurements where the water can be discharged from a closed pipe or conduit to the atmosphere. For commercial air measurement, or flue gas measurement, the Pitot tube, Fig. 2-d, is considered standard practice. The arrangement shown in Fig. 2-b is a typical setup for a fan test where it is necessary to determine not only the velocity but the total pressure as well. Figure 2-e is a commercial form of Pitot tube, which was formerly widely used with flow meters. The orifice and plug type meter, Fig. 2-h, was one of the first commercial steam meters developed, and is still widely used, especially in the district steam heating field. Another form used in Europe has a flat disc in place of the cone with the body of the meter shaped in the form of a nozzle so that as the disc raises the orifice area is increased.

Figure 2-i is a cylinder and plunger type, the rising plunger uncovering sufficient length of slot to pass the required flow. In all three of these types the movement of the plunger is an indication of the flow through the meter. The gate, Fig. 2-g, and vane, Fig. 2-k, are two forms of meters seldom used except for special condi-

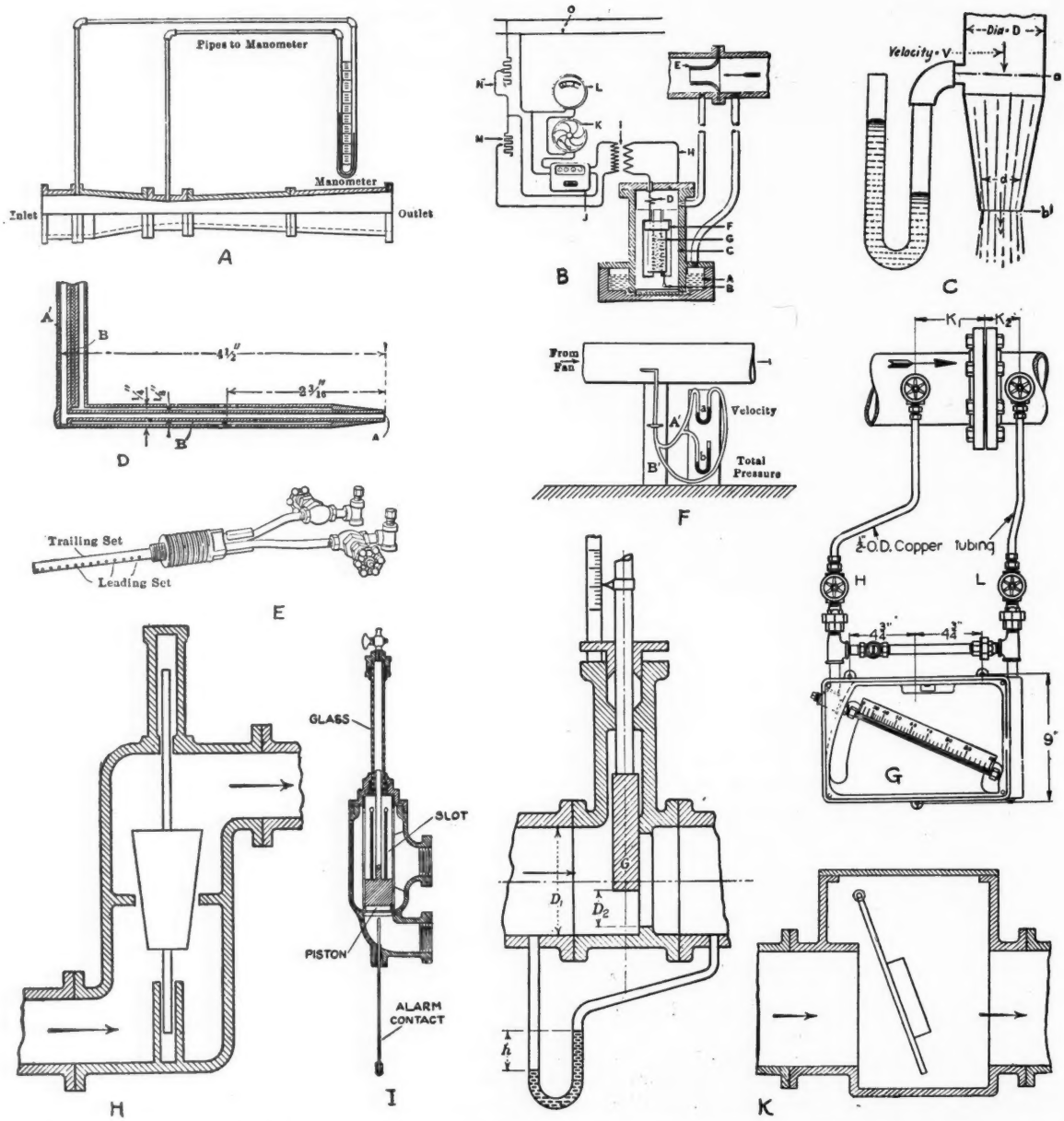


FIG. 2. A. VENTURI TUBE, B. FLOW NOZZLE WITH ELECTRIC RECORDING MECHANISM, C. NOZZLE, D. PITOT TUBE, E. COMMERCIAL TYPE OF PITOT TUBES FOR USE WITH FLOW METERS, F. ARRANGEMENT OF PITOT TUBES FOR FAN TESTS, G. PORTABLE TYPE OF FLAT PLATE ORIFICE METER, H. CONE AND DISK TYPE METER, I. CYLINDER AND PISTON TYPE METER, J. GATE TYPE METER, K. VANE METER

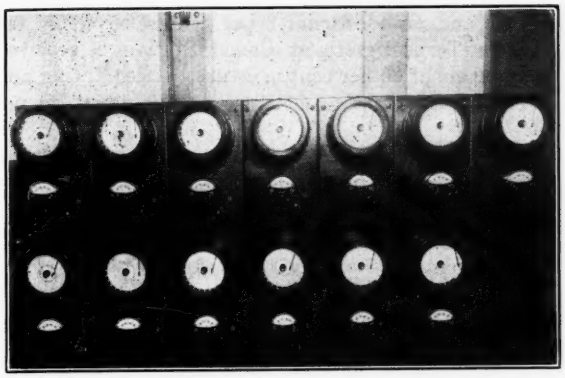


FIG. 4. TYPICAL GROUP OF 13 ELECTRIC FLOW METERS ON A CENTRAL BOARD

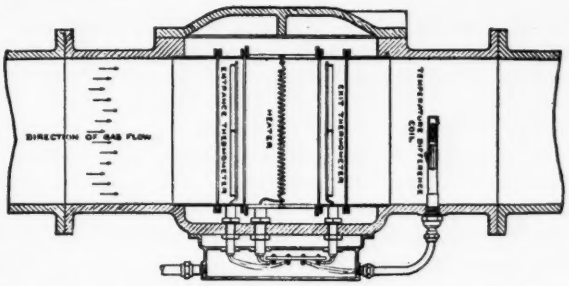


FIG. 5. ARRANGEMENT OF THE ELEMENTS OF AN ELECTRIC TYPE THERMAL AIR METER

tions, although if properly calibrated, their readings can be used to advantage, especially if no other method is available.

Thermal Electric Meter Used for Gas and Air

Thermal meters depending for their operating upon the specific heat and temperature changes of the materials measured have been developed. One such commercial meter, Fig. 5, for use with air or gas is considered extremely accurate. By means of a grid resistance across the conduit the air is heated by means of an electric current and from the heat input, temperature rise and specific heat, the quantity flowing is calculated. Originally a constant supply of current was provided and the temperature rise determined. This, however, has been changed and the temperature rise is now kept constant at 2 deg. F. by means of sensitive thermometers which control the flow of electric current through the resistance. The flow of current is, therefore, a measure of the air or gas flow through the pipe.

Conditions of proper installation, operation, errors and maintenance of the primary element are usually entirely different and independent from those of the secondary element. Naturally, if the primary element of the inferential type, such as an orifice, is installed under conditions where the pressure differential is not a proper measure of the flow, such as immediately following an elbow or reciprocating pump, the flow shown by the recorder will not be correct, even though the secondary element in itself may be accurate. By proper care and attention, reliable, accurate flow measurements can be obtained under practically any and all conditions. In themselves the meters are reliable, rugged and accurate, but they must be properly installed and maintained to give reliable records.

Importance of Drying Coal for Pulverizing

Allowable Moisture Depends upon Coal. Anthracite with 1.5 Per Cent Moisture May Cause as Much Difficulty as Texas Lignite with 25 Per Cent

TROUBLES FROM MOISTURE in pulverized coal, especially in plants using the central or bin system, are varied, starting at the pulverizer and continuing through the plant to the induced draft fans or air preheater, as the case may be. Mill capacity is lowered and the power consumption increased with the moisture content. This is shown effectively by Fig. 1, representing the performance of a 5000 lb. per hr. machine handling Illinois and Kentucky coals.

At 4000 lb. per hr. these tests, made at the Lafayette St. Station, show an increased power consumption per ton of about 13 per cent with a moisture increase of from 8 to 12 per cent. With a constant power input of 30 kw. the capacity of the mill is reduced from 4000 lb. with 8 per cent moisture to about 3150 lb. per hr. with 12 per cent moisture, a matter of about 21 per cent.

Bridging in the bunkers, arching over the feeder screws, uneven feeding with corresponding difficulty in controlling combustion and flame length, difficulty with the transport system, condensation on sides of screw conveyors and bunkers are all results of excessive moisture. In addition, the increased moisture lowers the boiler efficiency, overloads the fans at high ratings and greatly increases the wear and maintenance of the entire system.

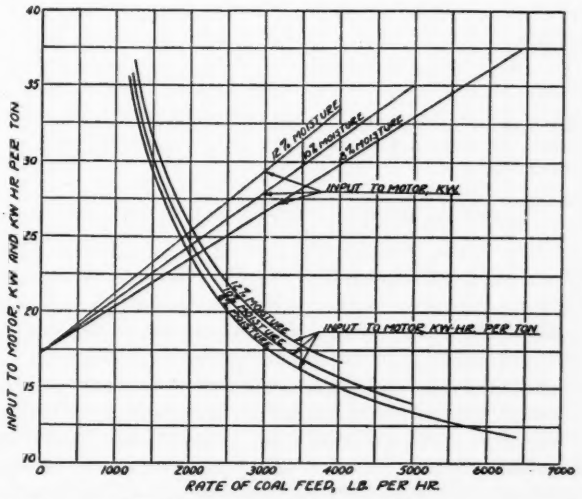


FIG. 1. SHOWING THE EFFECT OF MOISTURE ON THE CAPACITY AND POWER INPUT OF A 5000-LB. MILL

From a recent N. E. L. A. tabulation, listing 70 industrial and central stations using the central pulverized coal system, 50 dryer installations are reported, while only 10 definitely report no dryers. Of the 50 there are 17 waste heat or flue gas, 17 steam, 16 coal fired, one gas fired and one indeterminate. Two plants use both steam and flue gas and, of course, the majority of separately fired installations use pulverized coal. Dryer capacities range from 6 to 30 t. per hr.

Moisture contents of the coals represented range from comparatively low values for Eastern bituminous to 33 per cent in Texas lignite. The highest moisture content of coal used by plants reporting no dryers is 5 per cent.

Surface moisture rather than total moisture content of the coal is the index of its workability in a pulverizer, although the character of the coal must be taken into consideration as well. It is evidently the ratio of surface to chemical moisture that is the determining factor. Some companies report no difficulty with undried coal, while other companies using different coals with the same moisture find it necessary to dry it partially before pulverizing.

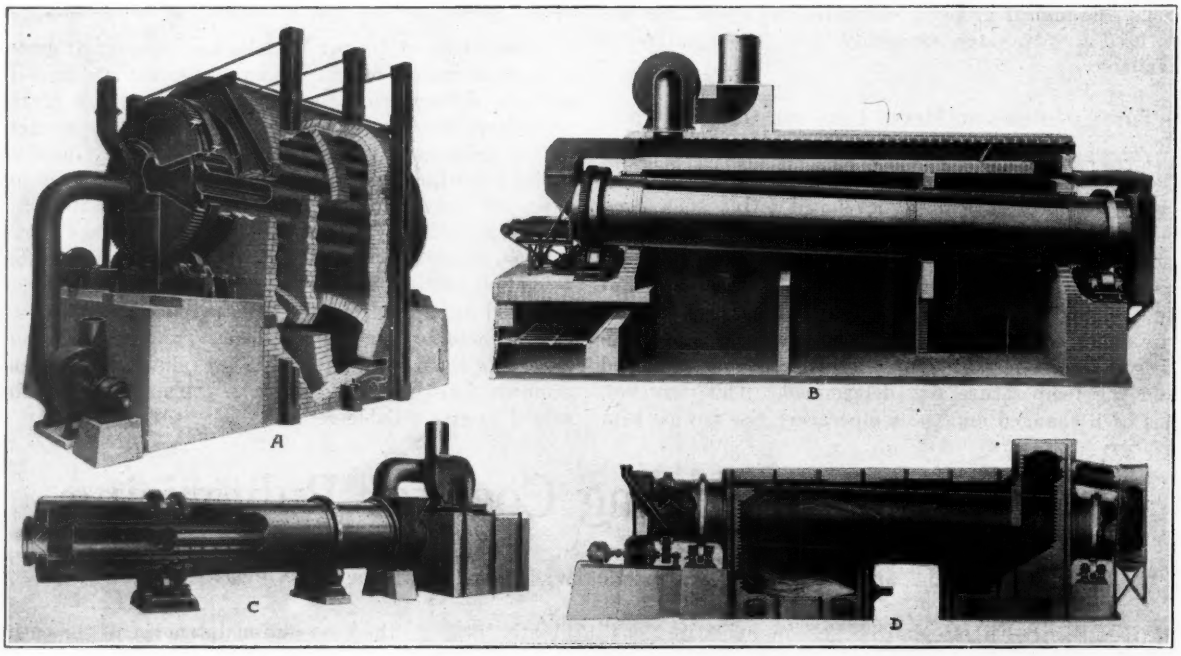


FIG. 2. SEVERAL TYPES OF SEPARATELY FIRED SEMI-INDIRECT ROTARY DRYERS

Allowable Moisture Depends on Type of Coal

Experience at Columbia Station, burning West Virginia coal, has shown that for the best overall operation the moisture content should be reduced to 1.7 per cent before pulverizing. Moisture in excess of 5 or 6 per cent causes difficulty at the Market St. Station, while at Calumet Station, Illinois coal leaves the dryer with about 10 per cent moisture and is fired without difficulty with about 9 per cent moisture. Colorado lignite with a moisture content in excess of about 20 per cent causes bridging in the bunker and combustion difficulties at Valmont Station. Here typical dryer performance delivers the coal to the pulverizers with about 20 per cent moisture and an additional 2 per cent removed by the mill. In Texas lignite at Comal Station is received averaging about 35 per cent moisture. After drying and pulverizing the average moisture is still about 28 per cent.

Coal to be pulverized may be dried in several ways; by hot gases, steam or warm air, using any one or some combination of the following methods:

1. Rotary dryers ahead of the pulverizer.
2. Stationary or rotary tower dryers ahead of the pulverizer.
3. Centrifugal dryers.
4. Admitting preheated air or flue gases into the pulverizing system.

Horizontal rotary dryers, several types of which are shown in Fig. 2, consist of an inclined longitudinal shell which revolves on rollers. Coal is fed into the upper end of the shell and travels by gravity through the dryer. These dryers are fired by either pulverized coal, stokers, hand fired or gas. In some designs the combustion chamber is built around the dryer shell, as shown in Fig. 2A, 2B or 2D. In others combustion takes place in the inside shell, as in Fig. 2C. Gases of combustion, being inert and having been cooled sufficiently in the first section, are brought back through the coal and discharged to an exhaust fan or natural draft stack to the atmosphere. With some coal it is desirable to discharge to a cyclone separator to recover the fine coal from the exhaust gases.

Waste heat, preheated air or flue gases are often used, several types of dryers designed for this service being shown in Figs. 3, 4 and 5. These dryers are all of the vertical stationary continuous type, operating by gravity. Undried coal enters the top and travels gradually toward the bottom. Some dryers have tunnels or ducts which can be oscillated either continuously or

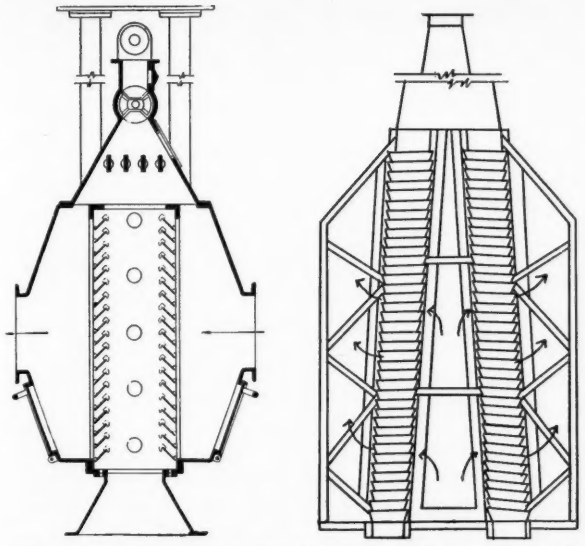


FIG. 3. TWO TYPES OF VERTICAL WASTE HEAT OR HOT GAS DRYERS

intermittently to prevent packing. The majority, however, prefer to take care of packing by making all angles with sufficient slope so that the coal will not lodge.

Drying Effect of Flue Gas Varies with Incoming Temperature

Tests made at Cahokia over a period of several months are shown graphically in Fig. 6. Coal as received averages 10.73 per cent moisture and the relation between the flue gas temperature into the dryers and the moisture content of the coal after drying is shown to be a function of the flue gas temperature. These tests developed the fact that less than half of the actual moisture removal occurred in the dryers. The coal absorbed heat there which served to evaporate the moisture when the coal was pulverized.

As a rule, when the flue gas temperature, because of the heat balance or station layout, does not exceed 300 to 350 deg. F., steam dryers are favored. Two types, a stationary (Fig. 7A) and a rotary (Fig. 7B) steam dryer are illustrated. The drying is effected by steam-heated, cast-iron grates and the moisture given off by the heated coal is absorbed by air drawn or forced through the coal by fans. In the stationary type gravity feed is used. In the rotary type the coal is scraped from one steam-heated shelf to the one below by revolving plows.

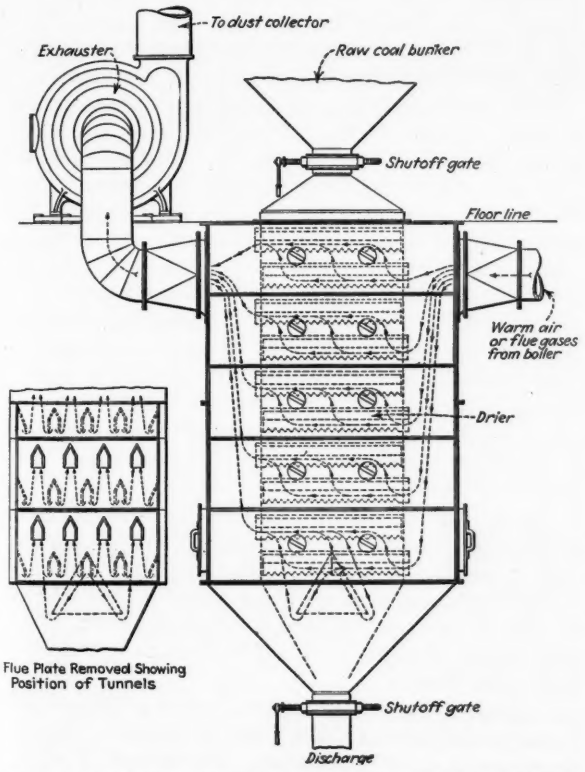


FIG. 5. ANOTHER TYPE OF DRYER SHOWING ARRANGEMENT OF FAN AND DUST COLLECTOR

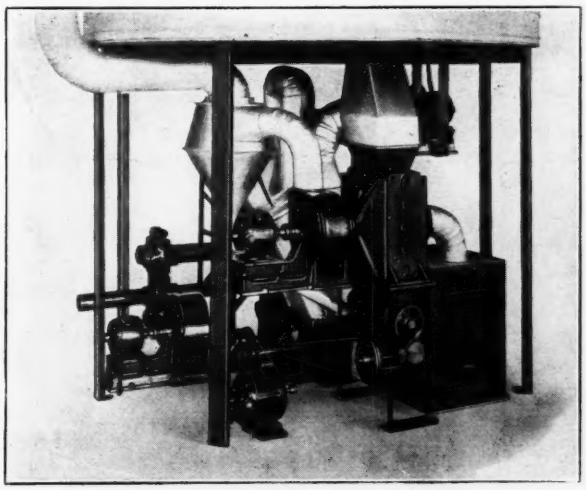


FIG. 4. COMPACT DRYER INSTALLATION SHOWING THE APPLICATION OF A SEPARATELY FIRED FURNACE

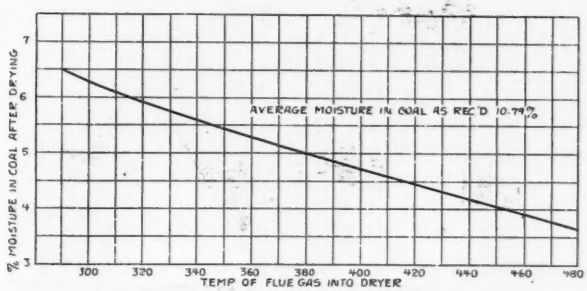


FIG. 6. RELATION OF FLUE GAS TEMPERATURE AND MOISTURE CONTENT OF COAL LEAVING THE DRYERS

Centrifugal machines of the type illustrated in Fig. 8 are now used extensively in coal washing plants and their success in this field in dewatering fine (minus ½ in.) has been so great that their entrance into the power plant field is eminent. Tests covering several months reported from the Minnequa Plant in Colorado on 99 per cent minus ½ in. feed Colorado coal showed an average drying of from 19.9 per cent to 5.5 per cent moisture. The extracted water is returned directly to

the circulation system with no building up of the fines in the system. Power consumptions range from ½ to 1 hp. per ton per hour, depending upon the coal and free moisture content. Estimated costs, including depreciation, power replacements, attendance and lubrication, run less than $0.025 per t.

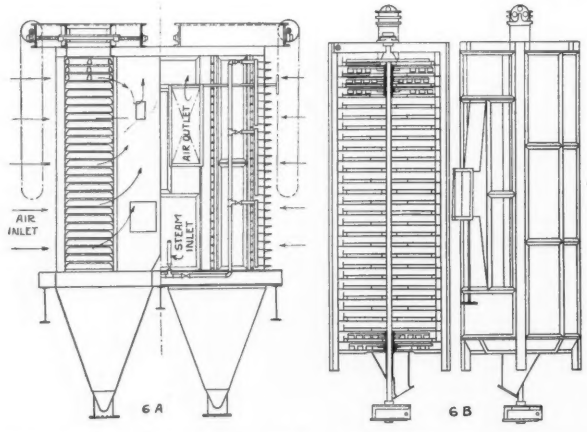


FIG. 7. STATIONARY (LEFT) AND ROTARY (RIGHT) STEAM DRYERS

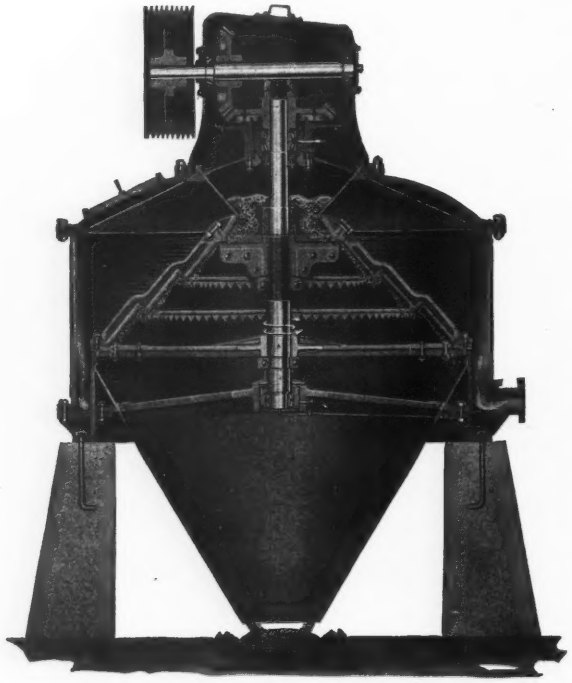


FIG. 8. ONE TYPE OF CENTRIFUGAL DRYER WITH CONTINUOUS FEED AND DISCHARGE

Admitting preheated air or flue gas into the pulverizing system has proven to be effective in many cases; with unit mills it is now standard practice as the coal, air and water are sent directly to the furnace. With the central system, however, venting the saturated air or gas from the system without an excessive loss of coal dust or difficulty with condensation is somewhat of a problem, although it is being successfully carried out in some plants.

Characteristics of Indiana Coals

INFORMATION in regard to the analyses and general characteristics of Indiana coals, mining methods employed in the Indiana coal mines, and the geological features of the coal fields of that State is contained in a report just issued by the United States Bureau of Mines, Department of Commerce.

The Indiana coal field forms part of the larger Eastern Interior field which covers parts of Indiana, Illinois, and Kentucky, says W. N. Logan, State geologist of Indiana, who contributes an article on the Indiana coal field to the report. The Indiana field covers portions of the western and southwestern parts of the State; it is bounded on the south by the Ohio River and on the west by the Wabash River and the northeastern Illinois boundary line. The coal-bearing area includes approximately 7000 sq. mi., or about one-fifth of the total area of the state.

There are more than 20 beds of coal in the state; 15 have been mined locally and 9 over large areas. The principal beds, named in the ascending order of stratigraphical position and age, are: Coal I, Lower Block, Upper Block, Minshall, Coal II, Coal III, Coal IV, Coal V, Coal VI, Coal VII, Coal VIII, Coal IX, Parker, Friendsville, and Aldrich.

All the coals belong to the bituminous class. Three kinds are recognized—block, cannel, and common bituminous. The block coal is divided into blocklike masses by vertical joints spaced 2 to 4 ft. apart and splits readily along bedding planes or laminations, which are marked by layers of mineral charcoal (fusain) interbedded with bright coal (vitrain). The blocks of coal do not break readily across the laminae and in weathering split rather than crumble.

The cannel coal is made up largely of spores and other small parts of plants, has a dull luster, and yields oil on distillation. Its surface looks slightly resinous, and its physical composition is more homogeneous than that of the other coals. It is only slightly laminated and is jointed somewhat like the block coal but breaks with a conchoidal fracture. Only a small quantity of this class of coal is produced in Indiana.

The greater part of the coal of Indiana is of the common bituminous type. It is generally bright on unweathered surfaces, breaks into somewhat cubical masses of variable size, and is not so strongly laminated as the block coal. The proportion of mineral charcoal is lower and the proportion of bright coal higher than in the block coal.

Production of coal in Indiana has approximated 22,000,000 t. annually in recent years. The Indiana coal field is well supplied with steam and electric railways, and the development of the coal industry is little affected by lack of adequate facilities for transportation. More than half of the coal produced in Indiana is consumed within the State.

Copies of Bureau of Mines Technical Paper 417, "Analyses of Indiana Coals," may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price of 10 cents.

Change in Boiler Plant Effects Large Savings

Evaporation Increased and Much Saving in Labor and Fuel Secured by Changes in College Point Plant of American Hard Rubber Co. By Henry A. Cozzens*

FOR YEARS the boiler plant of the American Hard Rubber Co., located at College Point, Long Island, consisted of five 250-hp. and one 460-hp. w. t. boilers, which had been in operation about 25 yr. Coal was received in barges and delivered to bunkers outside of the boiler house by a locomotive crane. From the bunkers, the coal was pulled by hoes into industrial railway firing cars. These had to be shunted on and off a coal scale and then pushed in front of the furnace where coal was hand fired. This handling of cars required a number of coal passers, creating confusion and interruption in firing.

During the war, the demand for steam became so great that turbine type fans were installed under each boiler to help out the draft which had been insufficient on account of the smallness of the stack. Maintaining steam pressure was somewhat of a problem and continued forcing resulted in a large repair bill. Every week-end it was necessary to pull all but two of the fires in order to renew brickwork and make grate repairs. Running with heavy ashpit blast raised havoc with the furnaces. With the large amount of stoker-fired plants in the vicinity, it became difficult to secure good firemen who could stand the strain and who would remain in the plant. These conditions also affected discipline and detracted from anything approaching efficient operation. In order to remove ashes, it was necessary to shut down the blower, open the ashpit doors and dig away with long-handled hoes. Ashes were placed in wheelbarrows and dumped outside the building for removal by the crane.

In addition to the above features, the plant had been designed with low settings and soon it was apparent that it was imperative that the production schedules must be arranged to suit the boiler plant. A new plant was discussed and studies were made on the advisability of building an entirely new plant in a new location or placing new boilers in the old plant. On account of the large investment already made in the adjoining power plant and some local considerations, it was decided to alter the old building and install new boilers. Adoption of this course meant that a portion of the old plant must be kept in operation until part of the new plant could carry the load. Seasonal slackness in the business during part of the time, aided by careful scheduling, accomplished this result.

It was necessary to excavate and build a basement under the front of the old plant. This required that the old boilers which remained in operation had to be underpinned in order to allow for building column foundations. This work was done on a 24-hr. basis over week-ends, thereby maintaining production required. The entire front wall was removed and firemen had to work out-of-doors wearing rubber coats during rainy weather. This situation did not help keeping firemen, but it proved who were the best and these were eventually taken over into the new plant. No man is now at work in the new plant who did not operate the old boilers.

Coal was handled by the car method in connection with a portable coal conveyor fed from a temporary wooden hopper which was kept filled by the crane. Ashes were removed as formerly. At the start of the

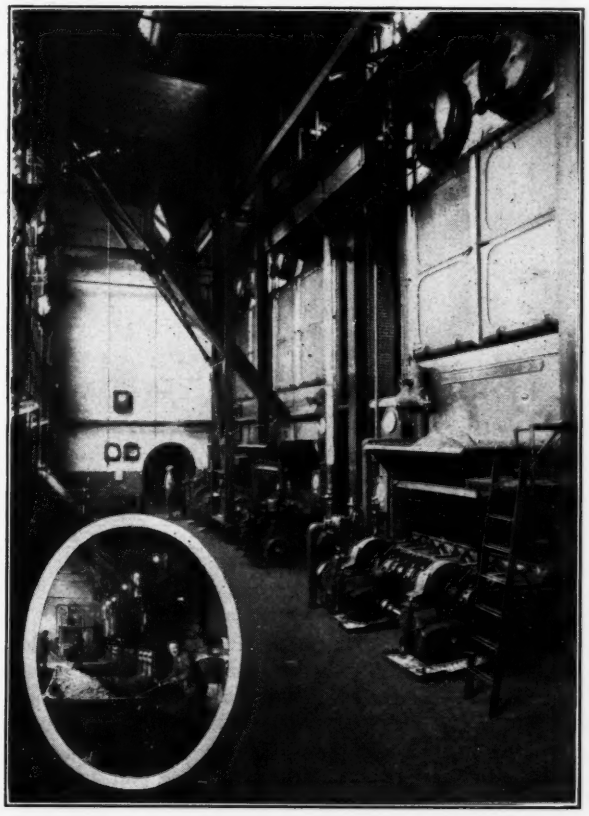


FIG. 1. VIEW OF FIRING AISLE SHOWING OLD AND NEW ARRANGEMENTS FOR HANDLING FUEL

operation, three of the old boilers were removed to enable the installation of the first battery of two new boilers. The new steam piping was hung from the new roof trusses at a considerable increase in height over the old piping. Temporary jumpers were arranged connecting the old and new piping so that either the old or the new plant could be operated. By this means the crews were educated and the new boilers were broken in and eventually carried the load. Permanent piping connections were made to the process and power lines.

After a trial period, the remaining three boilers were removed and the third boiler installed. The boiler room is rectangular in shape being 70 ft. 2 in. long by 57 ft. 3 in. wide and it was decided to install boilers arranged in one row facing the front wall. Three Babcock &

*Mechanical Engineer, American Hard Rubber Co., New York City.

Wilcox Co. longitudinal drum boilers, each with 5772 sq. ft. of heating surface were installed. Two boilers were mounted in a battery and the steel work was designed to accommodate a fourth boiler at some future time.

The boilers were designed to operate at a steam pres-pressure of 250 lb. with dry saturated steam. The operating pressure for the present is 150 lb. on account of the existing turbine plant. Each boiler has a heating surface of 5772 sq. ft., having two water drums 42 in. in diameter by 20 ft. 7 in. long, placed above and connected to a set of 18 sections of tubes, each section consisting

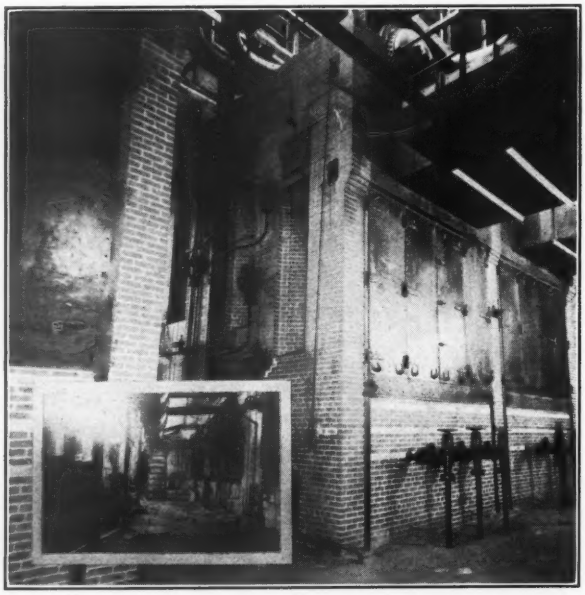


FIG. 2. REAR OF BOILERS ILLUSTRATING OLD AND NEW ARRANGEMENTS AND SHOWING MUCH MORE ORDERLY APPEARANCE OF LATTER

of 16 tubes 4 in. in diameter by 18 ft. long. The boilers are set 12 ft. above the boiler room floor. The mechanical stoker system consists of five-retort Riley Super-Stokers, 9 ft. 2 in. wide by 11 ft. 3 in. long, and having a projected grate area of 103 sq. ft. This gives a ratio of 56 to 1 between water heating surface and grate surface. This furnace volume is about 900 cu. ft., all measured below first row of tubes. Each stoker is driven direct by a 5 in. by 4-in. type S. H. Troy engine.

Consolidated safety valves and Reliance water columns with high and low alarms and Everlasting and Yarway blowoff valves are included in the equipment of the boilers. Each boiler is served by Diamond soot blowers. Separate steam lance connections are supplied at each boiler for breaking off slag when operating at low ratings. The forced draft equipment consists of two American Blower Co. forced draft fans, each having a capacity of 30,000 cu. ft. per min. at 5½ in. static pressure.

Fans of the double inlet type are used. They are arranged so that air may be drawn from the outside of the building or from the boiler room basement. One fan is driven by a 50-hp. General Electric single-stage steam turbine. The other fan is driven by a General Electric, three-phase, variable speed, slip ring type induction motor. These fans are located in the boiler room basement and are manually controlled from the boiler room floor. A new Kellogg perforated radial brick chimney, 180 ft. in height from the top to the foundation and with an internal top diameter of 10 ft. and internal bottom diameter of 15 ft. 9 in., was constructed at the rear of the boiler plant. The base of the stack is raised above the ground and soot is pulled out into an auto truck for cleaning.

Breeching of the accordion type, supplied by Connery & Co., is used. This company also supplied the forced air ducts which are of the same type. Soot blowers have been provided to clean out certain parts of the breeching where cinders accumulate.

Mechanical Fuel Handling Means Now Used

Coal is received at the dock in barges and is unloaded and placed on storage piles by a locomotive crane. This crane also reclaims the coal from the piles and feeds a crusher which is located on the dock. The coal from

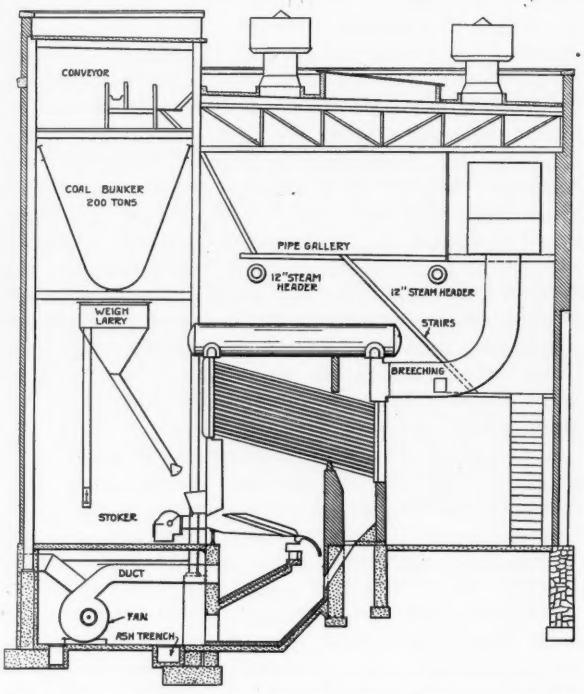


FIG. 3. CROSS SECTION OF BOILER ROOM SHOWING DRAFT AND BREECHING CONNECTIONS

the crusher is discharged to the tail end of a Robins horizontal 16-in. belt conveyor running in a concrete trench with wood top and delivering the coal into the boot of a belt and bucket elevator located in the boiler plant. From the head end of the bucket elevator, the coal is discharged on the tail end of the bunker conveyor which is equipped with a hand operated tripper and a two-way chute for discharging to the bunkers below. In order to receive coal brought in by trucks, an auxiliary hopper is located at the lower end of the elevator which can be used in case of an emergency. The bunker consists of a suspended type of 200 t. capacity equipped with four double cut off bin grates which are operated from the boiler room floor by chains.

These gates discharge into a 2000 lb. capacity motor propelled weigh larry. The bin extends only half of the width of the boiler room although end plates and brackets are provided for future extensions. The electrical system for coal handling is interlocked so that the bunker conveyor starts first and the other conveyors operate in sequence. Safety stop switches are provided at various points along the system.

Ash is delivered by gravity into the ash pits underneath the stokers. The ashes are withdrawn from the pits and deposited into a steam jet ash conveyor system furnished by the Conveyors Corporation of America. The ashes are received into a cylindrical cast-iron storage hopper located outside of the boiler plant. This hopper has a capacity of 25 t. and is arranged with two gates by means of which trucks may be loaded for the disposal of the ashes. The receiving hopper is vented into the former brick stack for which there was no further use. All ashpits are cleaned and moved to the tank at night by one man. This brings the ash blowing operation at the time of least rating and also, when the dust hazard is least objectionable. This man also has charge of the basement and keeps it clean. A pressure

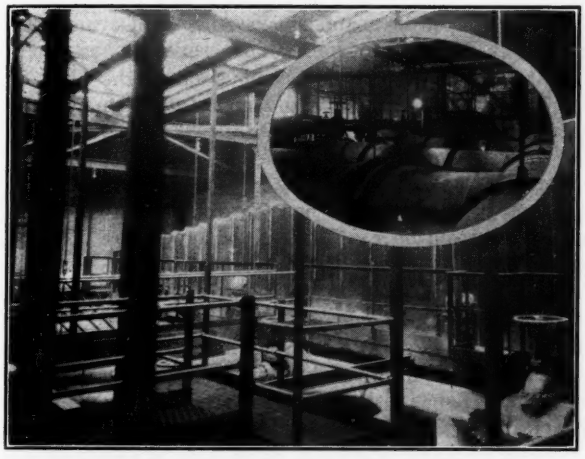


FIG. 4. PIPE GALLERIES AND BREECHING ILLUSTRATING OLD AND NEW ARRANGEMENTS AND SHOWING GREATER ACCESSIBILITY OF LATTER

gage is located on the steam line to the nozzle and this records the duration of blowing.

The brick settings were installed by George Allen & Sons and consist of Monarch brick for the double setting and Walsh brick for the single setting. The clinkering zones in the furnaces are provided with Bernitz superblocks and Carbofrax brick. The side and rear walls are faced with a red pressed brick while the fronts at the sides and above the two doors are faced with white enamel brick. The soot from the rear pass of each boiler is fed into the ashpits by means of two soot chutes per boiler.

Water from city service is first fed through rubber mills and miscellaneous equipment located in the factory buildings and is collected in a large basin just outside of the boiler plant. From this it is pumped into two tanks located in the top of one of the adjoining buildings. From these tanks the water flows by gravity into the Hoppes feedwater heater which is located in a small building between the boiler and turbine plants at the turbine room floor level. This water constitutes the makeup supply and the quantity is regulated as required. An emergency city water connection is also provided at the heater.

There are a number of pieces of equipment such as steam tables and traps which return hot water to the power plant and these are arranged so that separate lines come from various departments. All these lines discharge into a common manifold, thence into the heater. Valves are provided so that cold water may be returned to the basin in case too much water is being returned, thus using only the hottest water. Provision is also made to discharge this water into the sewer in case it should become contaminated with oil or foreign material. The condensate from the turbines is also dis-

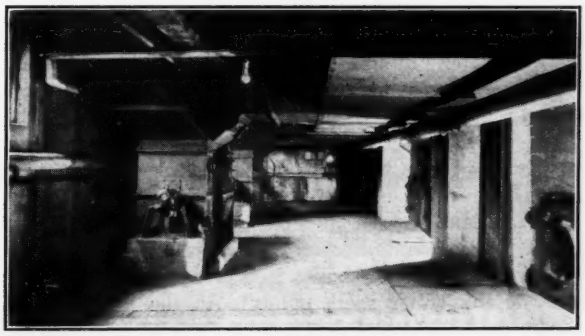


FIG. 5. BASEMENT SHOWING BLOWERS AND ASH REMOVAL SYSTEM

charged into the manifold with bypass features. The manifold is equipped with seals so that in case of trouble the pressure in the heater would be released before damage could be caused. The heater is arranged to overflow into the basin. It might be mentioned that the city water is used in the power plant only on oil coolers and turbine seals except in emergency. This is done largely from temperature and pressure consideration.

From the feedwater heater the water passes through a regulating Yarway V-notch weir and thence to the feed pumps. The weir is vented to allow air removal from the feedwater. Bypass provision is made around both the heater and weir. The feed pumps are the same as were used with the old boiler equipment and they are also arranged for cold water suction from the basin. Each boiler is equipped with a Copes feedwater regulator and the speed of the pump is governed by Fisher regulators. Exhaust steam for the feedwater heater is supplied by the feed and house tank pumps, air compressor, turbo driven blower and the stoker engines.

Provision is being made so that an excess of exhaust steam will be used to heat some of the buildings during the winter months. Considerable of this heating is now done by exhaust steam from various pumps and other equipment located about the factory. There is now an excess of exhaust steam but this will be reduced by the installation of electric driven auxiliaries and pumps in replacements. On week-ends the turbines do not operate during the day and steam-driven auxiliaries must be used in order to carry the steam load required for processes.

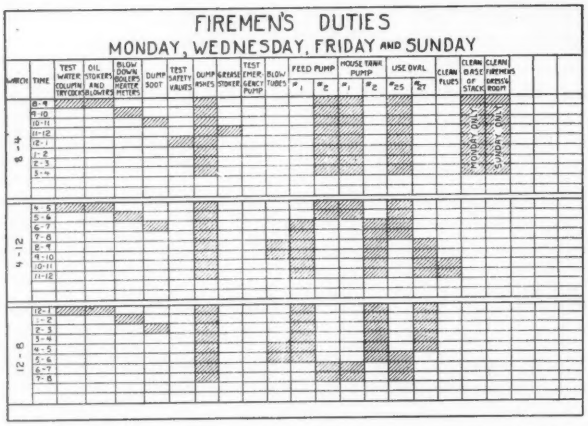


FIG. 6. CHART USED FOR SCHEDULING THE VARIOUS ASSIGNED DUTIES OF FIREMEN

Feedwater piping is arranged in the form of a loop, the upper part of which is over the boilers and supplies Copes regulators. The lower section passes through the basement, and risers are located alongside of each boiler so that they may be fed by hand from the boiler room floor. Arrangements are made so that the upper and lower sections may be operated separately, but pressure is now being maintained on the feedwater header at all times. An emergency boiler feed pump is located on the side of the boiler room opposite to the regular feed pumps and this pump draws cold water direct from the basin by means of a separate suction line. The emergency feed pump is so connected that either the upper or lower half of the ring may be used. Arrangements are made whereby the emergency pump will also permit the feeding of boilers through an auxiliary system not dependent on the present feedwater ring. This pump can also be used for house tank service and boiler washing.

The steam header system consists of a ring with means for segregating the front or the rear part of the header. The piping consists of extra heavy steel pipe with welded nozzles. Process steam used in the factory is required to be at 85 lb. pressure. It is necessary, therefore, to use reducing valves before the steam passes beyond the boiler plant. Behind the boilers are located two reducing valves and bypass sets through which the process steam passes and is metered. Beyond the reducing valves the pipe lines are divided to go to the various departments. Provision is also made for steam for the fire pump in such a way that the fire pump is always on the line regardless of which header is being used. At one end of the ring header a 10-in. line passes through the heater room and feeds the turbines. This line is also equipped with a flow meter. Provision is also made for supplying steam to the boiler plant auxiliaries at each end of the ring. Each boiler is fitted with two Foster automatic non-return valves and all of the stop valves were furnished by Jenkins Brothers. The pipe covering consists of 85 per cent magnesia blocks built up to 2 in. with ½ in. of cement and canvas sewed on. The smaller lines are covered with ordinary sectional covering. All pipe covering is painted with an identification color and is reinforced with metal for protection where rough usage is expected.

TYPICAL WEEKLY BOILER PERFORMANCE CHART WHICH IS POSTED IN THE BOILER ROOM AND WHICH PERMITS OF READY COMPARISON OF EFFICIENCIES OF FIRING GROUPS IN THE DIFFERENT SHIFTS

BOILER PLANT PERFORMANCE CHART

Shift	Men on Watch		Tuesday Dec. 13	Wednesday Dec. 14	Thursday Dec. 15	Friday Dec. 16th	Saturday Dec. 17	Sunday Dec. 18	Monday Dec. 19	Weekly Average
8 to 4	Ende Loll Barchett	Coal	29145	29475	28175	27150	12065	14160	32495	24465
		Steam	291000	287000	302000	286000	127000	133000	326000	250000
		Water	329250	315000	318750	311250	132750	146250	348750	271750
		Evaporation	11.30	10.69	11.31	11.46	11.00	10.33	10.73	11.02
4 to 12	Eggebrecht Koski Kuzminski	Coal	22240	22310	22360	20255	12250	18420	27550	20770
		Steam	236000	236000	234000	227000	139000	182000	271000	218000
		Water	249000	243000	247750	226750	142500	201750	297000	230000
		Evaporation	11.20	10.89	11.08	11.29	11.63	10.95	10.78	11.07
12 to 8	Wilday Geyer Jenke	Coal	20745	21340	21755	19530	14270	21235	23145	20290
		Steam	226000	214000	216000	196000	131000	208000	230000	206000
		Water	230250	234750	220500	204750	164250	232500	255750	220500
		Evaporation	11.10	11.00	10.14	10.48	11.51	10.95	11.05	10.87
Average Evaporation (Actual)			11.21	10.84	10.89	11.13	11.39	10.79	10.84	10.99
Boiler Efficiency (Apparent Efficiency No Corrections)			75.0%	73.0%	72.5%	74.5%	76.2%	72.0%	72.3%	72.5%

In front of each boiler is located a panel upon which are mounted the steam gage, a multiple-pointer gage showing the wind-box pressure, firebox draft and uptake draft. A Bailey boiler meter, recording the air flow, flue gas temperature and steam flow, is also mounted here.

At the present time the combustion in the plant is being controlled manually and strict attention is paid to the instruments on the boiler panels. The speed of the fans is controlled from the boiler room floor, and the volume of air to the wind box is controlled by two dampers per boiler which have rods passing up through the boiler room floor. The boiler dampers are also adjusted by hand to suit furnace conditions.

Liberal daylight illumination has been provided for by means of large windows in the front wall and a large skylight in the roof. This was necessary because the other three walls were without windows. Electric lighting in the firing aisle and in the rear is accomplished by means of signboard reflectors. Drop lights are used above the boilers. Portable cables are permanently attached and located at strategic points. All lights are controlled from the floor. Gage glasses have special reflectors. Pilot lights are provided on the coal larry.

Necessary Labor Much Reduced

Where it formerly was necessary to have 17 men to operate the boiler plant, only 11 are now employed. To operate the old plant 11 firemen, three water tenders and three repairmen were required whereas now only one fireman and one water tender work on each shift and four repairmen, three of whom act as relief men three days a week and the remainder of their time is occupied solely in repairs and improvements. This reduction of labor has brought about a saving of $750 to $1000 per month dependent on the overtime put in by the men under the old conditions.

An instruction book has been compiled to help the boiler room men in the operation of stokers, fans and ash system, etc., and in order to insure regularity in the performance of their duties a duties schedule has been drawn up. A log book is kept in the boiler room to be filled out by the water tenders who enter the time

of such routine duties as blowdown, testing of safety valves, greasing stokers, blowing tubes, dumping soot, oiling blowers, time of change of feed pumps, blower in operation, boilers in operation, time of bank, etc. The water tender also enters anticipated repairs and items coming up in his daily routine. Each day this log is submitted to the chief engineer who takes particular note of necessary repairs and gives the head repairman written instructions, keeping a copy of such orders for his own file. The head repairman keeps a log book in which he enters such items as repairs completed or under way, or any other information desired. In this way, the chief engineer is always in touch with the condition of all equipment.

As coal is taken from the overhead bunker a ticket is placed in the scale and punched by the water tender. At the end of each watch the coal tickets are turned over to the chief engineer along with the steam flow meter readings and the readings from the V-notch feedwater meter. By this means he is able to tell which shift is operating the most efficiently.

Due to manufacturing conditions, it is impossible to obtain the same efficiency on the night shift as on the day shift, so, in order to check the men fairly, a record is kept from week to week. This compares the efficiency of one gang against another for the same period. A copy is posted also in the boiler room at the end of each week. This draws a good deal of interest on the part of the men and shows them where they stand.

Evaporation Increased and Savings Effected

Through the installation of the new equipment the evaporation was increased from 8.5 to 10.5 lb. of steam per pound of coal, resulting in a yearly saving of $18,500 in the coal bill. In connection with the new plant the value of cleanliness cannot be expressed in terms of performance but its effect is evidenced by increased interest in the operating staff and facility of inspection. Banking losses have been cut to a minimum by reducing the ratings of the boilers according to the load rather than banking one boiler and operating the other boiler at a heavy overload.

The chief engineer makes out the daily log sheet which is sent to the mechanical engineer's office where the various figures are checked and entered and at the end of each month the mechanical engineer gets out a report showing unit costs and general items of plant performance.

Design and construction were carried out, under the supervision of the writer, by the Walter Kidde Co., Inc., of New York City, who were the general contractors. The operation of the plant is in charge of Charles Lusk.

Compressed Air for Soot Blowing at Columbia

After Exhaustive Tests, Air Was Adopted for Soot Blowing at Columbia as It Reduced Maintenance, Was Always Available, Proved as Effective as Steam and Reduced Boiler Makeup. By Jos. H. Heimbrock*

COMPRESSED AIR as a medium for blowing soot at Columbia Station was adopted after a considerable amount of test and research, relative to element and nozzle design to give the most efficient air consumption.

The following reasons for using air for soot blowing applied perhaps more favorably at Columbia than elsewhere: 1st—Since 600 lb. steam pressure is carried at the turbine throttle with 725 deg. F. total temp., ignoring the cost of high pressure piping, valves, etc., it was felt that maintenance for soot blowers would be much higher with steam than with air. 2nd—Reducing valves or orifice plates in the line were not looked upon with favor. 3rd—The constant availability of air made it possible for soot to be blown at any time, whether boilers were on the line or not. 4th—Tests proved that air was at least as effective in moving soot as steam. This was determined from comparisons with both the blower elements and hand lance. 5th—An item that weighed heavily against using steam was the numerous difficulties encountered with higher makeup water, which would be considerably increased if steam were used.

Air demands for other uses, such as in the pulverizer or coal preparation house, general plant use and the like, justified the installation of 1130-cu. ft. air compressors, with the usual spare. This gave an ample amount of available air to be used for the blowing of soot. To insure that pressure would be maintained, even with long continued blowing, large air tanks were installed.

*Chief Engineer, Columbia Station, Columbia Power Co., Cincinnati, Ohio.

Figures 1, 2 and 3 show a standard and a reheat boiler and economizer soot blower installation, with average gas temperatures at various locations, also the soot blower layout.

Tables I and II show detail descriptions of each element as well as other data obtained from tests.

Frequency of Blowing

Over a sufficient length of time and under the average conditions, tests proved that it is not necessary to blow each element three times a day or once per shift.

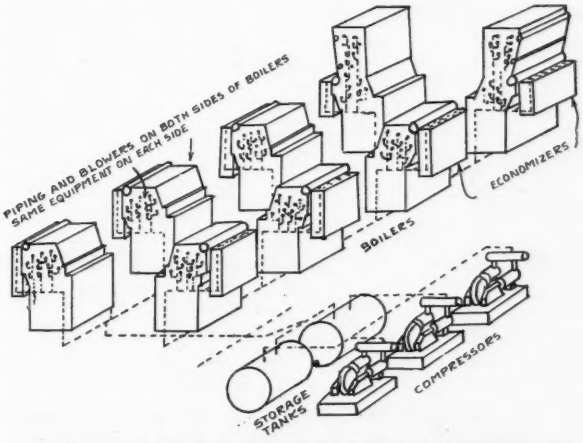


FIG. 1. LAYOUT OF AIR SOOT BLOWING SYSTEM AT COLUMBIA STATION

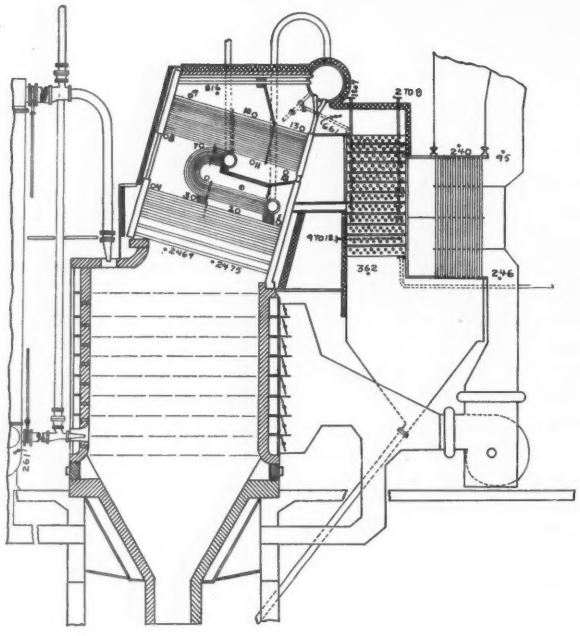


FIG. 2. SECTION OF STANDARD BOILER, SHOWING TEMPERATURES IN DEGREES F. AND POSITION OF SOOT BLOWERS

At Columbia, elements Nos. 1 to 8 are blown during the noon hour, and the evening light load period. All elements are blown on both the boiler and economizer some time after midnight. In normal operation this procedure of blowing is required daily on six of the eight boilers installed. Each boiler and economizer, when coming off for repairs, as well as going on the line, receives a complete blowing.

The following tabulation shows the average air and kw-hr. consumption of the air compressors, for a typical day's operation.

	For One Boiler and Economizer			Total
No. of blowing	1st	2nd	3rd	for day
Cu. ft. of air..	25,000	25,000	63,400	113,400
Kw-hr.	170	170	387	727

For six boilers and economizers a day this would give a total of 680,400 cu. ft. of air and 4362 kw-hr. used.

The following statement gives an average of 13 mo. operating and maintenance costs of the soot blowers:

Average monthly operation costs involved 265 man hours, giving a labor cost of $135.38; maintenance included labor $87.07, and material $21.17, giving total average monthly maintenance of $108.24. Thus the average monthly total cost for 13 mo., for soot blowers only, was $243.62.

TABLE I. SOOT BLOWER DATA, STANDARD BOILER

No.	Diam. Inside	Diam. Outside	Length	Nozzles Amount	Nozzles Size	Complete turns of Element	Time in Minutes to blow	Cu. Ft. of Air Per Minute	Cu. Ft. of Air Per two turns
1	1 7 8 in.	2"	12' 2"	19	1/4"	2	1.58	797	1259
2	"	"	"	"	"	"	"	"	"
3	"	"	"	"	"	"	"	"	"
4	"	"	"	"	"	"	"	"	"
5	"	"	"	36	"	"	1.55	1204	1866
6	"	"	"	"	"	"	"	"	"
7	"	"	"	"	"	"	"	"	"
8	"	"	"	"	"	"	"	"	"
9	2 in.	2 1/8"	"	"	"	"	1.25	1610	2012
10	"	"	"	"	"	"	"	"	"
11	"	"	"	"	"	"	"	"	"
12	"	"	"	"	"	"	"	"	"
13	"	"	"	"	"	"	"	"	"

Same number and kind on each side of boiler.

As shown on Figs. 1 and 2, the nearest point of location of the soot blowers to the furnace proper is on top of the lower bank of tubes. At the time of erection it was felt that no soot blower element had been developed that would exist a reasonable enough length of time at a location closer to the furnace. The present four lowest elements, however, cannot be expected to keep the two or three lowest rows of tubes clean. It is necessary, therefore, to clean them by the hand lance method, through side observation doors, about every 48 hr. Test elements are at present being installed directly over the second lowest row of tubes, to obtain information on their length of service and to justify an actual installation.

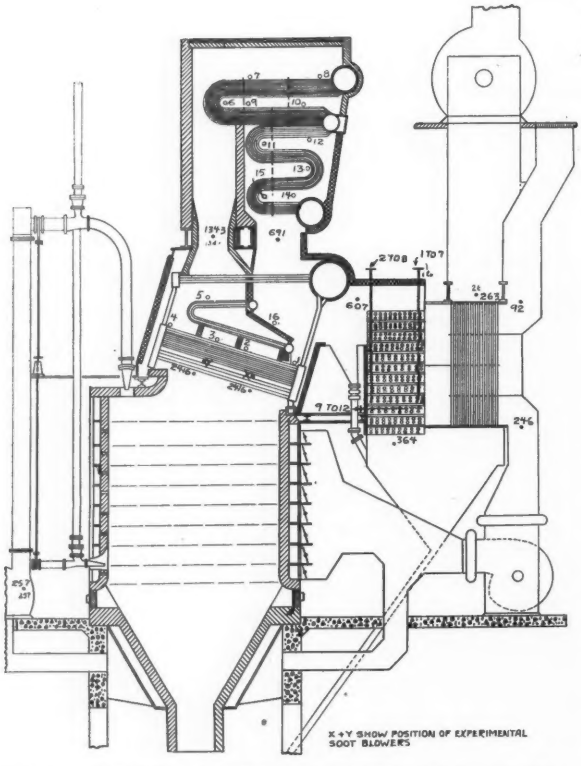


FIG. 3. SECTION OF REHEAT BOILER, SHOWING TEMPERATURES AND POSITIONS OF SOOT BLOWERS

TABLE II. SOOT BLOWER DATA, ECONOMIZERS

No.	Inside Diam.	Length	Nozzles Amount	Nozzles Size	Complete turns of Element	Time in Minutes to blow	Cu. Ft. of Air Per Minute	Cu. Ft. of Air Per two turns
1	2"	13'	23	1/4"	2	1.03	1213	1249
2	"	"	"	"	"	"	"	"
3	"	"	"	"	"	"	"	"
4	"	"	"	"	"	"	"	"
5	"	"	"	"	"	"	"	"
6	"	"	"	"	"	"	"	"
7	"	"	"	"	"	"	"	"
8	"	"	"	"	"	"	"	"
9	"	6' 1½"	38	5/16"	"	1.49	1395	2078
10	"	"	"	"	"	"	"	"
11	"	"	"	"	"	"	"	"
12	"	"	"	"	"	"	"	"

12 = Total of Elements on each economizer.
#1 to 8 inclusive are Vertical.
#9 to 12 " " Horizontal.

In the writer's opinion, soot blowers are one of the boiler's most important accessories and, unfortunately,

are often given very little attention. In a base load station such as Columbia, it is absolutely essential for a boiler to be kept on the line as long and as efficiently as possible. With proper supervision, it is not such a problem to maintain high boiler efficiency but the dust or slag formation generally is something beyond the control of the operator. When the dust accumulation affects the efficiency of the boiler by decreasing the heat transfer, blowing of soot is then resorted to. While blowing soot, which requires from one to two hours, the boiler is operated without regard to efficiency. The induced draft fan is pulled up to maximum capacity; steam output is low because of decreased coal feed and excess air. A considerable saving could be made if it were possible to cut down this time. By hand operation it is impossible, as there are quite a number of elements to blow. Some sort of automatic operation seems to offer great possibilities under such conditions, provided, of course, it could be made simple, fool-proof and reasonable enough in cost to justify the installation.

Since the adoption of the various new alloys for the elements, quite an increase of life is noted but there is room for improvement especially with element, nozzle and head design to obtain the very minimum air consumption for effective cleaning.

Element bearings, however, are in urgent need of improvement. In fact, it is not an exaggeration to state freely that if more attention were given the proper design of bearings, the life of the element would be increased 50 per cent.

Columbia Station has felt that air for blowing soot has been satisfactory. Exit gas temperature of 285 deg. at the stack, for an average of 20 mo., is sufficient evidence that soot blowers have done their job well in keeping both the boiler and economizer clean. That the soot blowers have stood up in spite of the high furnace temperature of modern installations is borne out by the fact that the total maintenance cost, including material and labor, has amounted to $1407.03 for the 316 elements installed for the past 13 months.

Results obtained with soot blowers at Columbia should not lead one to take this scheme as a sort of a panacea for all soot blower troubles. Since no two stations are identical, relative to design, load factor, and so on, what will prove entirely satisfactory in one may turn out to the contrary at another.

Diesel Engine Repair and Replacement Costs

RECORDS OBTAINED FROM 100 INSTALLATIONS OF DIESEL ENGINES INSTALLED SINCE 1914 SHOW LOW REPAIR COSTS

MODERN designs of Diesel engines suffer very little physical depreciation and a high grade Diesel engine, when properly maintained, may be expected to last quite as long as a steam engine operating under similar conditions.

It is natural that many, who are not directly concerned with the development of the Diesel engine, should continue to think of it in terms of its condition when it was introduced into this country not much over a quarter of a century ago. Difficulty has been experienced in obtaining reliable records of repair and replacement costs on Diesel engines partly because of the comparative infancy of the Diesel field and partly because most Diesel engines have heretofore been installed in industrial plants or in comparatively small power stations whose management usually fails to keep accurate maintenance cost records while such records are usually carefully kept in large central stations.

NEWER DEVELOPMENTS REDUCE REPAIR COSTS

Moreover, due to the great advances made in the selection, distribution and treatment of the materials used; in the design of parts and in the methods of lubrication and also to the increase in proficiency of operation during the past few years, wear and tear in Diesel engines have been much reduced.

It will be recalled that Dr. Rudolph Diesel once said, "But the Diesel engine is not and will not be a cheap engine; it aims to be the best engine and must be constructed of the highest class of materials with the most skilled workmanship." Twenty-five years ago skilled operators of Diesel engines were so scarce that it was necessary for the Diesel engine manufacturer to train such operatives. The engines, at that time, were not sold outright but leased to those wishing Diesel engines and operatives as well as the engines themselves were kept under the supervision of the parent company. As conditions have changed so radically since the introduction of the Diesel engine, it is fair to consider present improved conditions of operation to be conducive to lower costs of repairs and renewals. Accessibility and ease of inspection and repair with reduction in the weights of parts to be handled, which have characterized the later designs of Diesel engines, also tend to reduce these costs.

One manufacturer, Busch-Sulzer Bros. Diesel Engine Co. of St. Louis, has compiled the table shown, which tabulates the various repair parts which have been added to 100 engines of their newer design, type B, which had been installed between and including the years 1914 and 1923. It also shows the amount of wear suffered by the various wearing surfaces of these engines. The number of engines of each size which were reported in this table, are as follows:

13—520 br.hp.	6760 br.hp.
21—365 br.hp.	7665 br.hp
15—250 br.hp.	3750 br.hp.
19—180 br.hp.	3420 br.hp.
18—165 br.hp.	2970 br.hp.
14—120 br.hp.	1680 br.hp.
100 Engines. Total	26,245 br.hp.

The average years of service of these engines so far has been 6.85 and the average operating hours and inspection periods have been:

Total time in actual operation (average of 67 engines) ..... 31,770 hr.

WEAR AND PARTS REPLACEMENT RECORD OF 100 DIESEL ENGINES

ENGINE NO.	ENGINE B.H.P.	YEAR INSTALLED	HOURS OPERATED SINCE INSTALLATION	AVERAGE HOURS BETWEEN STOPS	AVERAGE LOAD K.W.	PEAK LOAD K.W.	FREQUENCY OF GENERAL OVERHAUL MONTHS	FREQUENCY OF ROUTINE INSPECTION AND ADJUSTMENT DAYS	HEADS & PISTONS REMOVED	PISTON PIN BEARINGS					CRANKPIN BEARINGS			
										NUMBER REPLACED	WHEN	GREATEST WEAR INS.	LENGTH OF SERVICE	NO. THS. BEFORE FIRST ADJ.	NUMBER REBABBITTED	WHEN	GREATEST WEAR INS.	LENGTH OF SERVICE
418	520	1915		160	330	345	6	7	When necessary to take up pins	None			23 Mo.	2	None			23 Mo.
438	520	1915		12	300	350	24	7	2 Years	None				8	None		.006	10 Yrs.
457	520	1917	19,857	Varies	260	350	12	30	Annually	1	1925	.004	9 Yrs.	3	3	1925	Slight	9 Yrs.
459	520	1916	75,000	32	200	300	12	7	Annually	None		.005	10 Yrs.		None		.018	10 Yrs.
460	520	1916	76,000	164	200	350	12	7	Annually	2	1923–25	.009	9 Yrs.	3	3	1–1920 2–1925	.050	9 Yrs.
516	520	1919		60 days	250	400	12	60	Annually	1				1	None			
517	520	1921		12	250	350			6 Mo.	None		.015	5 Yrs.		2			
518	520	1918	18,143	Varies	260	350	12	30	Annually	None		.004	8 Yrs.	3	1	1926	Slight	8 Yrs.
520	520	1919	37,810	24	280	340	12	1	6–12 Mo.	None		.013	8 Yrs.	3	None		.060	6 Yrs.
541	520	1920	30,193	24	280	340	12	1	6–12 Mo.	None		.015	5 Yrs.	2	None		.050	5 Yrs.
542	520	1920	50,000	32	200	300	12	7	Annually	None		.005	6 Yrs.		None		.015	6 Yrs.
543	520	1921	24,790		280	323	12	30	Annually	1		Slight	5 Yrs.		None		Slight	5 Yrs.
545	520	1923	15,915	19	275	375		7	Once	None		.004	3 Yrs.		None		.005	3 Yrs.
445	365	1916	See note	144	Full load	Full load	12	7	Annually	None			10 Yrs.	2	4	1920		10 Yrs.
501	365	1918	35,968	14 4	94	265	12	14	Annually	None		.007	8 Yrs.	4	1	1925	.029	8 Yrs.
502	365	1917	39,000	72	120	250	12	90	Annually	None		.006	8 Yrs.	4	1	1920	.020	8 Yrs.
503	365	1917		18	180	200	108	30	3 Mo.	1	1926	.020	9 Yrs.	1	2	1924–26	.012	9 Yrs.
505	365	1920	26,280	12	250	345	12	30	Annually	1	1922	.004	6 Yrs.		None		.012	6 Yrs.
527	365	1920	27,598	72	130	250	12	90	Annually	None		.006	5 Yrs.	8*	1	1922	.018	5 Yrs.
528	365	1920		160		250	12	7	Annually	None			5 Yrs.	3	3	1924		
530	365	1919	43,090	See note	150	290	12	7	Annually	None		.003	7½ Yrs.	8	None		.020	7½ Yrs.
546	365	1920	19,520	16	150	225	12	365	1 Year	None		.004	6 Yrs.	5	1	1924	.025	6 Yrs.
547	365	1921	27,600	100	300	No peak	None	15	Have not been removed	None		.006	5 Yrs.		None		.008	5 Yrs.
548	365	1921	32,269	See note	360 H.P	340–410 H.P.	Twice in 5 Yrs.	Monthly—busy season 3–4 Mos.	Annually	None		.003	5 Yrs.	3½	1	1926	.025	5 Yrs.
549	365	1921	23,529	14 6	85 K W	265	12	14	Annually	None		.005	5 Yrs.	3	None		.018	5 Yrs.
550	365	1921	32,829	See note	360 H P.	340–410 H.P	Twice in 5 Yrs.	Monthly—busy season 3–4 Mos.	Annually	None		.002	5 Yrs.	3½	1	1926	.020	5 Yrs.
656	365	1921		8	170	170	6	14	6 Mo.	None		004	4½ Yrs.		None		.005	4½ Yrs.
657	365	1921	12,000		190	200–225	12	30	Annually	None		Slight	5 Yrs.		None		Slight	5 Yrs.
690	365	1922	See note	144	175	250	12	7	Annually	None		.006	4 Yrs.	1	None		.004	4 Yrs.
691	365	1922	15,863	30 days	275	325	12	7	6 Mo.	None		No. Adj.	4 Yrs.	4*	None		Abt. .010	4 Yrs.
692	365	1922	14,965	30 days	300	325	12	7	6 Mo.	None		No. Adj.	4 Yrs.	4*	None		.010	4 Yrs.
693	365	1922	10,930	16½	153	276	12	30–45	Annually	None		.006	4 Yrs.	1	None		.008	4 Yrs.
715	365	1923	25,902	16½	175	225	12	7	Once since installation	None		No. Adj.	3 Yrs.	3*	None		.006	3 Yrs.
441	365	1915	Not known	152	200	260	4 Times in 11 Yrs.	7	6 Mo.	None		.002	11 Yrs.	8	4	1917	.005	9 Yrs.
451	250	1921	Aver 8 Hr. per day	8	150	175	24	7	2 Yrs.	None				5	None			
453	250	1915	82,140	2 Wks.	110	150	24	14	2 Yrs.	4	1922	.004	4 Yrs.		4	1922	.005	4 Yrs.
455	250	1915	Not known		100	125			Annually	None		.010	11 Yrs.	2				
472	250	1915	Not known		100	125			Annually					2				
480	250	1915		144	160	200	12	7	Annually	None				4	4	1922		
483	250	1915	27,790	18	120	210	12	90	Annually	None		.004	11 Yrs.	6	1	1922	.020	11 Yrs.
535	250	1916	Aver 8 Hr per day	8	150	175	24	7	2 Yrs.	None					None			
626	250	1920	32,500	2 Wks	120	150	24	30	Annually	1	1924	.004	4 Yrs.		None		.007	6 Yrs.
628	250	1921	30,900	500	150	168*	60	30	5 Yrs.	None		.007	5 Yrs.	5	None		.005	5 Yrs.
629	250	1921	28,750	500	150	168*	60	30	5 Yrs.	None		.006	5 Yrs.	5	None		.002	5 Yrs.
648	250	1921	9,000	17–20	60	118	None	30	None	None				5½	None			
652	250	1922		6			6 Mo.	14	6 Mo.	None		Slight	4 Yrs.	4*	None		Slight	4 Yrs.
709	250	1923	See note	144	Full load	Full load	12	7	1 Yr.	None			3 Yrs.	2	None			3 Yrs.
603	250	1919		144	130	160	2 Times in 7 Yrs.	7	6 Mo.	None		.002	7 Yrs.	7	2	1924	.005	7 Yrs.
604	250	1919		144	130	160	2 Times in 7 Yrs.	7	6 Mo.	None		.002	7 Yrs.	7	None		.005	7 Yrs.
605	180	1919	13,500	11½	Constant load—H.P. unknown		6 Mo.	30	6 Mo.	None		.003	7 Yrs.	4	None		.005	7 Yrs.
606	180	1919	42,672	1440	30	102	2		Annually	None				6	None			
608	180	1919	3,800	140	30	130	12	30	Not Yet	None		Very little	7 Yrs.	3	None		2 Shims removed	7 Yrs.
612	180	1920	45,000	18	65	114	6	14	6 Mo.	None		.005	6 Yrs.	3	2	1924	.018	6 Yrs.
614	180	1920	25,985			100	12	365		None		.005	6 Yrs.	1	None		.007	6 Yrs.
620	180	1920	25,395			100	12	365		1	1925	.005	6 Yrs.	1	None		.007	6 Yrs.
621	180	1920	23,000	168	50	100	12	7	1 Yr.	None		.004	6 Yrs.	3	None		.007	6 Yrs.
636	180	1921			85	130	Once	When needed	Once	None		.005 Abt.	5 Yrs.	3	None		.008	5 Yrs.
637	180	1921			85	130	Once	When needed	Once	None		.005 Abt.	5 Yrs.	3	None		.008	5 Yrs.
639	180	1922	11,774	77	45	92	12	7	Annually	None					None			
643	180	1921	See note	168	45	110	12	7	Annually	None		No. Adj.	5 Yrs.	5*	None		.010	5 Yrs.
644	180	1921	19,115	15	50	130	Once in 1923	30	2 Yrs.	None		Hardly Noticeable	4 Yrs.	4	None		Slight	4 Yrs.
645	180	1921	32,000	168	44	100	12	7	6 Mo.	None		.003	5 Yrs.		None		.005	5 Yrs.
646	180	1922	28,600	170	70	130	12	7	6 Mo.	None				5*	1	1926	.006	4 Yrs.
686	180	1922	18,000	288	80	80	12	Twice a month	Annually	None				4*	None			
687	180	1922	17,040	288	80	80	12	Twice a month	Annually	None				4*	None			
689	180	1923	12,000	3–7 Da	140 H.P.	160	24	100	2 Years	None		No. Adj.	3 Yrs.	4*	None		No. Adj.	3 Yrs.
701	180	1923	10,000	168	30	100	12	7	6 Mo.	None		.003	2 Yrs. 7 Mos.		None		.005	2 Yrs. 7 Mos.
702	180	1923	13,480	170	70	130	12	7	6 Mo.	None		.004	3 Yrs.	3*	None			
425	165	1920	25,000	168	90	120	6	7	6 Mo.	None		.002	5 Yrs.		None		.004	5 Yrs.
426	165	1915	80,718	166	100	125	12	7	1 Yr.	None		No. Adj.	11 Yrs.		None		.022	11 Yrs.
428	165	1915	See note	7 Da.	50	100	12	7	Annually	None		.004	11 Yrs.	11*	None		.012	11 Yrs.
429	165	1915			30		6	180		None					4	1920		
470	165	1916	68,320		75	115	12	Annually	Annually	None		.004	10 Yrs.	4	None		.025	10 Yrs.
471	165	1916	38,782	1740	55.5	102	6	90	6 Mo.	None		.004	10 Yrs.	5	4 Upper halves	1924–25	.007	10 Yrs.
472	165	1916	39,778	1820	55.6	100	6	120	6 Mo.	None		.004	10 Yrs.	5	2 halves	1924	.004	10 Yrs.
484	165	1917	See note	160	80	100	96	7	Annually	None		.006	8 Yrs.	6	4	1925		1 Yr.
487	165	1917	60,000	168	50	100	12	7	Yearly	1	1920	.006	9 Yrs.	4	1	1921	.007	9 Yrs.
611	165	1919	17,600	168	60	115	12	90	6 Mo.	None		.004	7 Yrs.	3	2	1926	.004	7 Yrs.
610	165	1919	17,500	168	60	115	12	90	6 Mo.	None		.005	6½ Yrs.	3	None		.005	6½ Yrs.
609	165	1919	18,260	168	60	115	12	90	6 Mo.	None		.004	7 Yrs.	3	None		.004	7 Yrs.
521	165	1919	35,000	350	85	110	6	60	6 Mo.	None		.010	7 Yrs.	7	1	1926	.015	7 Yrs.
607	165	1919		150	125	155	12	90	Annually	None		.051	7 Yrs.	7	None		.002	7 Yrs.
613	165	1916		168	90	120	6	7	6 Mo.	2		.004	10 Yrs.		None		.006	10 Yrs.
638	165	1920		8	50	75	12	180	Annually	None		Slight			None		Slight	
640	165	1921	42,640	164	14	40	None	Weekly	Once 5 Yrs.	None		Slight		3	None			
641	165	1921			70	120	12	30	Annually	None		.018	5 Yrs.		None		.017	5 Yrs.
424	120	1914	60,000	720	100 H.P.	100 H.P.	12	30	Annually	None		.004	12 Yrs.		1	1924	.010	12 Yrs.
446	120	1915	79,800	1440	60	80	120	60	10 Yrs.	None		.006	10 Yrs.	10	None		.015	10 Yrs.
476	120	1916	75,000	20	35	75	12	7	Once or Twice per year	None		.010	10 Yrs.	4	None		.010	10 Yrs.
511	120	1922	9,855	3.50	50	80	12	7	Annually	None		.002	4 Yrs.	3	1	1925		
512	120	1916		6			6	14	6 Mo.	None				8	None			
513	120	1916		6			6	14	6 Mo.	None				8	None			
536	120	1920	41,000	144	60	80		180	6 Mo.	None		.010	6 Yrs.	7	None		.005	6 Yrs.
537	120	1920	14,400	11	85	110	12		1 Yr.	None		.004	6 Yrs.	2	None			
538	120	1920		15	55	118	12	30	1 Yr.	None		.010	6 Yrs.	6	None		.022	6 Yrs.
540	120	1919					Once in 7 Yrs.	7	Once	None				7*	None			
632	120	1920	30,000	720	100 H.P.	100 H.P.	12	30	1 Yr.	None		.003	6 Yrs.		None		.010	6 Yrs.
633	120	1920	25,560		80 H.P.	120 H.P.	Whenever stopped	Never	Never	None				6*	None			
634	120	1920	37,000	18	60–90	95	None	7	Never	None				6*	None			
635	120	1922	25,920	338	46	80	12	14	1 Yr.	None		.003	4 Yrs.	4*	None		.012	4 Yrs.

*At times 10 to 20% overload

*Not adjusted to date.

WEAR AND PARTS REPLACEMENT RECORD OF 100 DIESEL ENGINES (CONTINUED)

WEAR AND REPLACEMENT OF PARTS																REMARKS
MAIN BEARINGS				CYLINDER LINERS				CYLINDER HEADS		PISTONS		PISTON RINGS		COMPRESSOR VALVES		
NUMBER REBABBITTED	WHEN	GREATEST WEAR INS.	LENGTH OF SERVICE	NUMBER REPLACED	WHEN	GREATEST WEAR INS.	LENGTH OF SERVICE	NUMBER REPLACED	WHEN	NUMBER REPLACED	WHEN	NUMBER REPLACED	WHEN	NUMBER REPLACED	WHEN	
None			23 Mo.	None			23 Mo.	None		None		1 Set		6		
None		.000	10 Yrs.	None			10 Yrs.	10		None		8	1922	6	1924	
None		Slight	9 Yrs.	1	1925	.025	9 Yrs.	2	1923–25	1	1925	30	1920 23–25	1 Set	1925	
None		.010	10 Yrs.	4	1924	.013	2 Yrs.	1	1926	None		2 Sets	1920–24	8 or 10		
None				2	1920–23	.064	9 Yrs.	3	1–1920 2–1925	3	1–1920 2–1925	44				
5				2	1920–24					2						
				None		.031	5 Yrs.	1				1 Set				
None		Slight	8 Yrs.	None		.026	8 Yrs.	2	1920–25	None		28		1 Set	1921	
1	1924	020	6 Yrs.	1	1922	092	6 Yrs.	2	1926	4	1925	48		None		
None		031	5 Yrs.	None		082	5 Yrs.	3	1925	4		40	20–1924 20–1926	One		
None		Slight	6 Yrs.	1	1924	.022	6 Yrs.	None		1	1924	None		None		
None		.012	5 Yrs.	1	1925	.010	5 Yrs.	1		1	1925	96		1 Set	1924	
None		008	3 Yrs.	None		.005	3 Yrs.	None		None		3		None		
None			10 Yrs.	4	1920		6 Yrs.	None		2	1918	120	12 ea. yr 6–1924 6–1925	1 H.P.	1923	Engine ran 10 yrs., 9 mo. per yr., 6 days per wk., 24 hrs. per day.
None		009	8 Yrs	None		.029	8 Yrs.	None		None		12		26		
None		012	8 Yrs.	None		.065	8 Yrs.	6	1919–25	5	1919–25	3 Sets		2 H.P		
None		.006	9 Yrs.	4	1926	Oldliners 100	8 Yrs.	4	1922–23 –26	4	1926	24 ea. yr.		None	In past 2 yrs.	
None		.012	6 Yrs.	None		.010	6 Yrs.	None		2	1921–22	17		1	1923	
None		All O.K.	5 Yrs.	None		.034	5 Yrs.	4	1923–24	3	1923–24	2 Sets	1923–25	2 H.P.	1923–25	
None		.017	5 Yrs.	3	1921 23–26	.012	5 Yrs.	None		3	1921–25 –26	40 Average 2 rings on each piston each overhauling	8 ea. yr.	3 H.P	Every 15 mos.	
None		.014	7½ Yrs.	1	1923	012	7½ Yrs.	4	1922–23	4	1924–26			1 H.P	1925	Note: 1st 3½ yrs. aver. stop of 3 hrs. per wk. 18 hrs. per day since.
None		.060	6 Yrs.	1	1923	.100	6 Yrs.	1	1923	1	1923	60		None		
None		005	5 Yrs.	None		.008	5 Yrs.	None		None		None		1	1923	
None		.006	5 Yrs	None		.006	5 Yrs.	None		None		Renewed	1926	1 H.P.	1924	Note: Busy season 2285 Winter 12
None		.006	5 Yrs	None		018	5 Yrs.	None		None		10	7–1924 3–1925	4		
None		.006	5 Yrs	None		.007	5 Yrs.	1	1926	None		Renewed	1926	None		Note: Busy season 2420 Winter 12
None		.004	4½ Yrs.	None		003	4½ Yrs.	None		None		6		None		
None		.010	5 Yrs.	1	1925	.014	5 Yrs.	1	1925	1	1923	4 Sets	1 ea. yr.	1 Set	1924	
None		004	4 Yrs.	None		008	4 Yrs.	None		None		8		None		Note: 18 hrs. per day 2 yrs. 24 hrs. per day since.
None		.004	4 Yrs.	None		.013	4 Yrs.	None		None		5	1925	None		
None		No Adj.	4 Yrs.	None		.011	4 Yrs.	None		None		5	1925	None		
None		.005	4 Yrs.	None		.015	4 Yrs.	None		None		2		None		
None		.005	3 Yrs.	None		Slight	3 Yrs.	None		None		3	1925	None		
5	1917	010	10 Yrs.	4	1925–27	.042	11 Yrs.	4	1923	6		3 Sets		1 H.P.	1924	Note: Engine in fire, rebuilt 1917.
None				4	1924			1	1926	2	1921	12		4	1925–26	Originally installed 1915
None		.008	11 Yrs.	4	1922			4	1922	4	1922	54	1922–24–25	3		
				4	1925											
				4	1925											
None			11 Yrs.	4	1919–20		5 Yrs.	4		1		72		1 Set		
None		.004	11 Yrs.	1	1917	.055	11 Yrs.	7	1916–20	4	1916–20	3 Sets	1915–25	2 Sets	1915–25	
None				None		.015	10 Yrs.	2	1923	None		16	1924	3	1923–25	
None		.005	6 Yrs.	2	1924			2	1924	2	1924	24	1924	2	1924	
None		.002	5 Yrs.	None		.027	5 Yrs.	None		None		8	1920	None		
None		.002	5 Yrs.	None		.023	5 Yrs.	None		None		6	1920	None		
None				None				None		None		None		1	1920	
None				None				None		None		Not known		6		
None		3 Yrs.		None			3 Yrs.	None		None		2 ea. piston ea. yr.		1 H.P.	1923	Note: 3 yrs.; 10 mos. per yr, 6 days per wk., 24 hrs. per day.
None		.005	7 Yrs	1	1921	.042	7 Yrs.	2	1925	2	1921	112		1 H.P.	1926	
None		005	7 Yrs.	None		.040	7 Yrs.	1	1925	None		112		1 H.P.	1926	
None		.005	7 Yrs	1	1926		7 Yrs.	2		9		102		1 H.P. 1 L.P.	1925	
None				None				None		None		24		3 I.P. 4 H.P.		
None				None			7 Yrs.	None		None		None		1 Set		
None		.005	6 Yrs.	None		.025	6 Yrs.	None		None		68		6 ea. stage	1 per. yr.	
None		.007	6 Yrs.	None				None		None		48		3 ea. stage		
None		.007	6 Yrs.	4	1926	.025	6 Yrs.	None		1	1925	48		3 ea. stage		
None		005	6 Yrs.	None		.023	6 Yrs.	None		None		48	Top 3 ea. yr.	3 or 4		
None		.008	5 Yrs.	None				None		None		4	1924	4 or 5		
5	1924	.008	2 Yrs.	None				None		None		2	1924	4 or 5		
None		.004	4 Yrs.	None				None		None		None		1 Set	1926	
None		No Adj.	5 Yrs.	None		.013	4 Yrs.†	1		None		46		2 H.P.		Note: Continuous except 2 hrs. ea. Sunday.
None		Slight	4 Yrs.	None		Slight	4 Yrs.	None				8	1923	1 H.P.	1923	Plant destroyed by fire 1923. Engine out of service 1 yr.
None		.005	5 Yrs.	1	1926	.004	5 Yrs.	None		1	1926	8		3 Sets		
None		.005	4 Yrs.	None		Slight	4 Yrs.	None		None		24	1925	All	1925	
None				None				None		None		8	1925	None		
None				None				None		None		4	1925	None		
None		.006	3 Yrs.	None			3 Yrs.	None		None		8	1925	1 H.P.	1924	
None		.004	2 Yrs. 7 Mos.	2	1926			None		1	1926	12	1926	2 Sets	1926	
None		003	3 Yrs.	None				None		None		12	1926	None		
5	1924			None		.008	5 Yrs.	3		None		24		8		Note: Originally installed 1915
None		.006	11 Yrs.	None		.014	11 Yrs.	4	1915	None		44		4 Sets		
None		006	11 Yrs.	4	1925			None		None		4 per. yr.		25		Note: Continuous except when overhauling.
None				1	1920			8	4–1920	4	1920			12		
None		006	10 Yrs.	4	1920	.100	6 Yrs.	4	1922	None		60		3	1920–22–23	
None		005	10 Yrs.	1	1921	006	10 Yrs.	3	1921–23	None		48		4		
None		.005	10 Yrs.	1	1925	.006	10 Yrs.	2	1925	None		36		3		
None		006	8 Yrs	3	1925	014	7 Yrs.	5	2–1924 3–1925	3	1925	4 Sets		12		Operated continuously for 8 yrs. day and night.
None		.003	9 Yrs.	None		.022	9 Yrs.	None		None		3 Top rings	Ea. Yr.	6 or 8		
2	1926	.005	7 Yrs.	None		.005	7 Yrs.	None		None		12	1926	2		
None		.004	6½ Yrs.	None		004	6½ Yrs.	None		1	1926	24	1926	2		
None		.003	7 Yrs.	None		.003	7 Yrs.	None		None		6	1926	3		
None		.020	7 Yrs.	None		Slight	7 Yrs.	None		None		140	10 ea. 6 mo.	14 Ea.		
None		.010	7 Yrs.	None		.030	7 Yrs.	None		None		None		1	1925	
None		.008	10 Yrs.	4	1923	.002	2 Yrs.	6		4	1923	48		6		
None		Slight		None		Slight		None		None		24	1926	1 Set	1926	
None				None				None		None		12		3 Sets		
None		.024	5 Yrs.	1	1926	011	5 Yrs.	None		1		32				
None		.006	12 Yrs.	4	1926			None		None		48		2		
None		006	10 Yrs.	None		.031	10 Yrs.	None		None		24	1926	4 L.P. 3 I.P. 5 H.P		
None		.012	10 Yrs.	4	1924	.006	2 Yrs.	4		None		24		3 Sets		
None				None				4	1923–25	None		48	1922–25	1	1925	Originally installed 1917
None				None				None		None				6		
None				1	1922			None		1	1922			None		
2	1922			None				1	1923	None		184		10		
None				None				None		None		15		2		
None		.030	6 Yrs.	None		.018	6 Yrs.	3	1923	None		90	8 ea. yr.			
None				None				None		None		24		3 L.P. 3 I.P 5 H.P.		
None		.005	6 Yrs.	None		.020	6 Yrs.	None		None		24	1924	4		
None				None				None		None		None		1 Set		
None				None				None		None		None		1		
None		.006	4 Yrs.	None			4 Yrs.	None		None		2		2		

†Last measured 1925.

Total time in service (average of same 67 engines) ..... 6.4 yr.
Per cent operating time to total (based on same 67 engines) 56.5
Average duration of run between stops (based on 82 engines) .....236 hr.
Average duration of run between overhauls (based on 92 engines).....19.2 mo.
Average time between routine inspections (based on 92 engines) .....45 days
Average time between removals of heads and pistons (based on 92 engines).....15.95 mo.

One 520-br.hp. engine (No. 459) which was installed in 1916 has run 75,000 hr. A second similar size engine (No. 542) installed in this same plant has run 50,000 hr. The average cost of repair parts on this plant has been $616.25 per engine per year. Replacements in all of the engines reported may be summarized as follows:

Piston pin bearings.....
.....16 replaced on 8 engines—none on 92 engines
Crankpin bearings.....62 rebabbited out of 400
Main bearings.....25 rebabbited out of 500
Liners replaced .....
.....The average age of liners replaced was 6.88 yr.
Cylinder heads replaced.....One per engine per 5.5 yr.
Pistons replaced.....One per engine per 7.8 yr.
Work. Cyl. rings replaced.....Five per engine per year
Compressor valves replaced...One per engine per 1.6 yr.

Maximum wear of parts as reported show:

65 Engines—maximum wear on piston-pin bearings averaged .....0.0063 in. per engine
These bearings averaged 6.7 yr. in service—
Equiv. wear .....0.00094 in. per eng. per yr.
64 Engines—maximum wear on crankpin-bearings averaged .....0.0133 in. per engine
These bearings averaged 6.6 yr. in service—
Equiv. wear .....0.002 in. per eng. per yr.
64 Engines—maximum wear in main bearings averaged .....0.00985 in. per engine
These bearings averaged 6.6 yr. in service—
Equiv. wear .....0.0015 in. per eng. per yr.
57 Engines—maximum wear on liners averaged .....0.0263 in. per engine
These liners averaged 6.3 yr. in service—
Equiv. wear .....0.0042 in. per eng. per yr.

Wear of main bearings is reported as maximum at 0.066 in. and minimum at 0.002 in. with an average of 0.0015 in.

The facts stated as well as further study of the table indicate that the Diesel engine has advanced to that stage of development that should warrant its consideration as motive power in much more extended fields than has heretofore been common.

Automatic Control in Czecho-Slovakian Plant

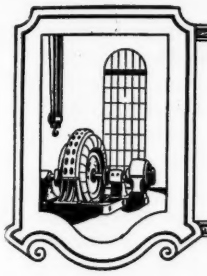
VARIABLE LOAD CONDITIONS MET BY AUTOMATIC COMBUSTION CONTROL. BY CHAS. J. WEBB

AT THE electric power station at Holeschowitz, near Prague, in Czecho-Slovakia, a plant at which the load is extremely variable, an interesting form of automatic control of the boilers devised by Herr Ing. Roucka of Blansko, Moravia, has recently been adopted with, it is stated, excellent results.

In the case of variable loads it has been found that the efficiency of a boiler can be increased if the rate of combustion can be varied in accordance with the load and it was to meet this requirement that the Roucka automatic arrangement was devised. It consists of a series of levers connected up to a servo-motor which, by means of oil under pressure, operates the adjustment control apparatus. In the Roucka system the levers are constantly in a state of vibration, thus they are more ready to respond instantly to any movement than if they were entirely at rest. Altogether eight different controls are comprised in the system as follows:

(1) A combustion regulator which acts on the valve controlling the combustion gas passage; (2) a vacuum regulator in the furnace, which varies the amount of air entering below the grate; (3) a feed-water regulator controlled by a float which follows the level of water in the boiler and (4) a fuel-feed regulator by means of which the steam generation is kept proportional to the quantity of air admitted. The various controls are electrically connected to a multi-meter provided with measurement indicators and recorders. The four other portions of the automatic control mechanism indicate the steam pressure, the degree of superheat, feed water temperature and per cent CO_2.

Herr F. Karas, the engineer of the Holeschowitz power station, has recently drawn up a report on the working of the Roucka installation, a summary of which is appended. The load at this station is extremely variable. Thus in one month it varied daily between 2000 and 32,500 kw. During the night it was necessary to shut down many of the boilers and to restart them during the day and periods of peak loads. The loss of heat due to these conditions may be estimated as representing 3 per cent in summer and 5 per cent in winter of the total coal consumption. As a result of the modernization of the plant a few years ago—by the installation of new boilers and the adoption of turbines—the heat units per kilowatt-hour fell to 33,000 B.t.u. This, however, was not equal to the anticipated economy but even the installation of indicators showing the carbonic acid gas contents of the fuel and the establishment of a fuel laboratory did not result in any improvement. It was then decided as an experiment to fit three of the boilers with Roucka eight indicator multimeters, the results of which were so satisfactory that the 12 new boilers, working at 220 lb. per sq. in., have since been fitted with similar apparatus and the 14 old boilers which deliver steam at approximately 185 lb. per sq. in. with triple indicator multimeters showing the quantity of air and steam and the temperature of the combustion gases. As a result of the automatic installation, the efficiency of the boilers has increased from 58.25 per cent to 70 per cent while the heat units per kilowatt-hour have fallen from 33,000 to 27,800 B.t.u. Herr Karas adds that the apparatus has worked well although it needs constant supervision and requires to be tested at regular intervals.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Use of Oil Circuit Breakers on Power Lines

OIL CIRCUIT BREAKERS SHOULD BE SELECTED WITH FULL CONSIDERATION OF THE SERVICE ON WHICH THEY ARE TO BE USED. BY H. J. LINGAL*

UNTIL QUITE recently the oil circuit breaker has not received the attention it deserves. With the growth of power systems and with the consequent increase in the values of currents to be handled, the importance of the oil breaker has become increasingly evident and at the present time an earnest effort is being made to improve its characteristics and extend its application.

The statement has been made that "the oil circuit breaker is to the power line, what a valve is to a water line." This is correct only to a limited degree. The only function of a valve, in the sense implied in the foregoing sentence is to start and stop the flow of water subject to the control of an operator.

By stopping and starting the flow of electricity the circuit breaker performs similar functions in an electrical system but here the similarity between the valve and the breaker ends. While the function of the oil circuit breaker is primarily to start or interrupt the flow of energy, the performance of this act must be accomplished often under great difficulties. The A. I. E. E. have defined the oil circuit breaker as a device, other than a fuse, constructed primarily for the interruption in oil of a circuit under infrequent and abnormal conditions. From this it is evident that a circuit breaker is not intended to be operated under entirely normal conditions.

In order to function properly, without disturbance to other parts of the system, it is important that the circuit breaker shall perform its work within very definite limits of time and be sufficiently flexible in this respect that it can be applied without undue complications. There is, of course, a limit to how flexible any piece of apparatus can be made without incurring unproportional expense. The control of the time element is obtained through different means, depending upon the importance of the time factor, the accuracy required, and very often by the amount of money the engineer in charge of the design of the installation can afford to spend for this feature. Where the installation is of sufficient importance to justify it and where close accuracy in this respect is necessary, the time factor should be obtained by the use of dependable relays used in connection with transformers. This is the only method recommended where accuracy in the time element is required. An apparatus of this kind is shown in Fig. 1.

In a good many applications it is not necessary to incur the expense of an equipment such is shown in

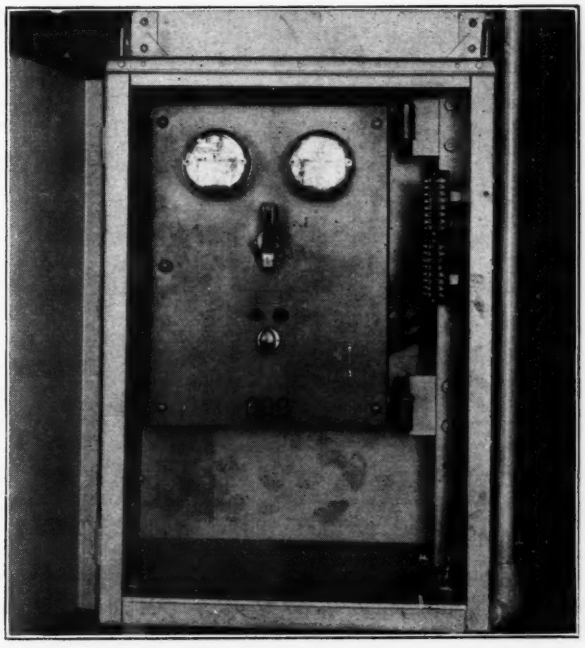


FIG. 1. CIRCUIT-BREAKER SET UP WITH RELAYS AND TRANSFORMERS

Fig. 1. Where close accuracy is not required, or where the time control is intended to be used solely to prevent the breaker from opening under overloads of short duration, and moderate amount, the purpose can be accomplished in a satisfactory manner, by the use of an attachment known as the inverse time element. Generally, this device is constructed in the form of a dash-pot and is attached to the tripping solenoid. The tripping time on such a device will vary approximately inversely to the current. All such devices are subject to variation in tripping time with variations in temperature. Since most of these devices use a form of oil as a means of obtaining the time, there will be a change in the accuracy of the device owing to the change in the

*Circuit breaker engineer, Westinghouse Electric and Manufacturing Co.

viscosity of the oil due to age, or to having absorbed foreign elements. This change can be kept within satisfactory limits however by changing the oil in the dashpots at reasonable periods. A device of this nature is capable of being adjusted over a reasonable range, in both time and current settings. Such a device is shown in Fig. 2.

Effects of Temperature

When applying such devices, precautions must be taken to protect them from extreme temperatures. Where such precautions cannot be taken, the method shown in Fig. 1 should be used. In putting breakers into service, the time element should be adjusted by the persons in charge, to suit the conditions of that particular installation. The instruction book accompanying each breaker should be consulted for instructions regarding the setting. In some cases protection for the time element against temperature variations can be procured without expense to the installation by using breakers in which the time element dash-pots are immersed in the circuit breaker oil. This system of protection is quite commonly used on breakers designed for outdoor use. Such a design is shown in Fig. 3 wherein the dash-pot oil is kept at a good operating temperature by the heat from the breaker contacts.

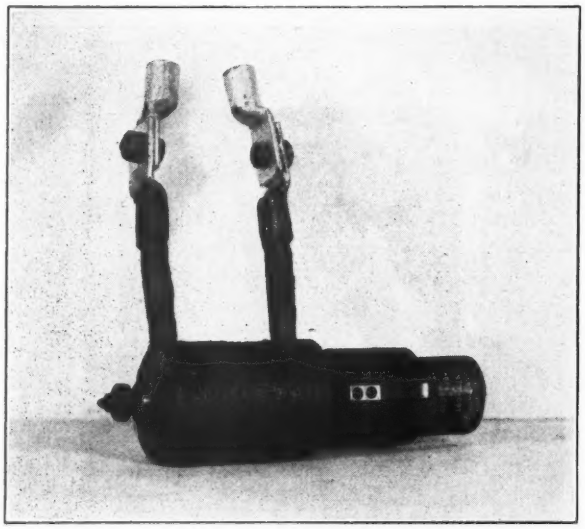


FIG. 2. INVERSE TIME ELEMENT

Oil circuit breakers like any other piece of machinery, will give best results when the temperatures under which they operate are moderate. Any extreme drop, or extreme rise, in temperature may affect the operation of the breaker unless the proper provision is made at the time the application is made, to take care of such a situation. In designing apparatus of this class an ambient temperature of 40 deg. C. is assumed as the maximum room temperature in which this class of equipment will be used. If the application is made in a place where the breaker will be subjected to greater external heat, it is to be expected that there may be evidence of unusual heating, perhaps above the allowable total temperature when subjected to duty at or near its rating. If it is known in advance that high external temperature will be encountered, the condition may be provided for by the selection of apparatus having a rating sufficiently greater than required for electrical reasons, to compensate for the increased external temperature. Selection of the next larger size of breaker according to the published rating, will usually provide sufficient margin.

It is just as important to consider the effect of extremely low temperatures on the operation of such apparatus as it is to consider and provide for the effects of the high temperatures. Generally speaking, oil circuit breakers are designed in three different types, namely: indoor, outdoor and subway, each kind being especially suited for the class of service designated by its name. Naturally it is expected that the lowest temperatures will be met, in apparatus which is used outdoors, unless special provisions are made to take care of maintaining the temperature at a suitable point. The breakers that are designed for outdoor use are usually so designed that any reasonable drop in temperature will not interfere with their satisfactory operation. It is not intended to leave the impression here, however, that because apparatus is designed for outdoor service, it will operate dependably under all conditions. While a breaker is closed, and current near the rating of the breaker is passing through it, there will be considerable heat given off in the breaker which will very likely keep the temperature inside the breaker at a safe operating point. This will be especially true in breakers where the operating parts are enclosed in the main housing of the breaker along with the current carrying parts.

Insulating Oils for Circuit Breakers

Oils of all kinds increase in viscosity as the temperature drops. Circuit breaker oils are selected with a view to keeping the change in viscosity down to the minimum, but at very low temperatures such as may be encountered in some of the northern states, a decided thickening of the oil may take place, which might possibly interfere with the automatic operation of a breaker which for instance had been standing open for some time. The oils selected by the breaker manufacturers are most suitable for use in that particular apparatus, since oils having different characteristics may interfere with the dependable operation of such automatic features as the oil dashpots used in connection with time elements, where the time is regulated by the opening or closing of a port or ports to regulate the rate of flow of oil from one chamber to another.

In installations where dust or dirt is present in any unusual quantity, particular attention should be given to the selection of a breaker of a suitable design to protect the oil from being contaminated by collections of such foreign substance, as well as to guard against the weakening of the insulation by the collection of dust on the insulating members. The dielectric strength of insulating oils is rapidly reduced by the addition of even a very small percentage of dust or water. In fact the presence of so small an amount of water as one part in 10,000 will make insulating oil unfit for use in high voltage oil circuit breakers. In such cases dust-proof or moisture-proof breakers should be selected. The application of breakers in places like grain elevators where great quantities of inflammable or explosive dust is pres-

ent and where the failure of a breaker might cause the ignition and a resultant explosion of the dust, special precautions should be taken to provide locations for the breakers in well ventilated rooms where the dust is excluded. In applications of this kind it is just as important to enclose all control relays properly so that arcs drawn from them cannot ignite collections of dust which might result in an explosion. It is also important to consider properly the kind of duty the breaker will be used for. An oil circuit breaker deteriorates somewhat each time it is used to open or close a circuit

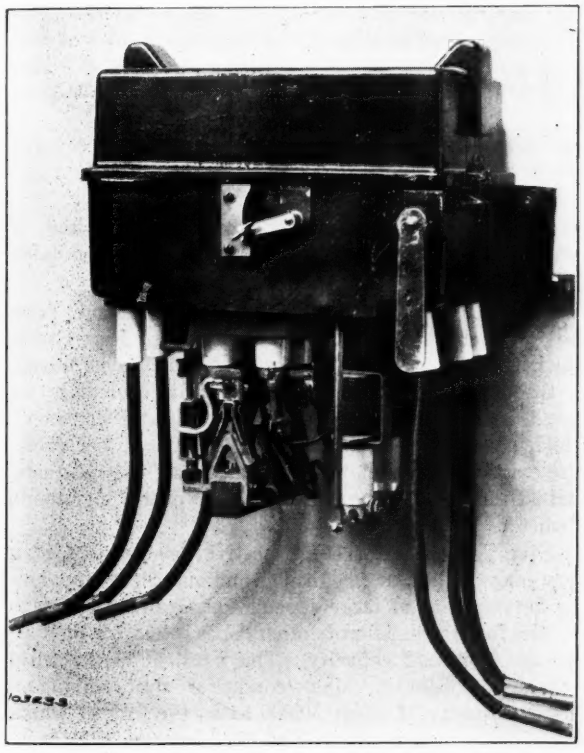


FIG. 3. OIL IMMERSED INVERSE TIME ELEMENT

through which current is passing. This deterioration is due mainly to the carbonizing of the oil by the electric arc drawn during the breaker operation. The more frequently the breaker is operated, and the more current interrupted, the faster the depreciation will be. After the oil has depreciated until its dielectric strength has been lowered to about 16,000 v., when tested in a standard test cup, it may no longer be fit for use in circuit breakers. It is not advisable to continue operation after this point has been reached.

Other conditions which require special consideration in breaker application include such things as:

(a) Exposure to damaging fumes or vapors.
(b) Exposure to salt spray.
(c) Exposure to vibration or shock.
(d) Operation in damp places, or exposure to weather, for indoor equipment.
(e) Application of breakers in high altitudes.

Most economical circuit breakers have a high speed of separation of contacts. This is a material advantage, in that it is a big factor in interrupting a maximum kv.a. in the minimum space, and in the shortest possible time, thereby keeping the system disturbance to the minimum and incurring the lowest possible cost for housing space. This feature requires a free moving, quick acting mechanism. In all mechanisms it is a well recognized fact that bearings which are subjected to acid fumes, vapors or such other things as salt spray may become corroded or oxidized to such an extent that it may interfere with the free and uninterrupted operation of the mechanism. Where it is necessary to make applications under such conditions, everything possible should be done to protect the equipment from such effects; in addition, breakers should whenever possible, be selected which have the mechanism enclosed insofar as possible or in which exposed parts are made from non-corrosive material.

All applications of oil circuit breakers are considered "special" when they are used in altitudes exceeding 3300 ft. (1000 meters).

In all such cases the published voltage rating of the breaker must be multiplied by correction factors as shown in the following table:

Altitude in Ft.	Correction Factors
3300	1.00
4000	0.98
5000	0.95
10000	0.80

When breakers are installed where they may be subjected to jar, shock or vibration, accidental tripping may be guarded against by using mechanisms on which the latching members are so constructed that they are "jar-proof," i. e., they are so constructed that the latch is positively locked in such a manner that it can only be tripped through the regular tripping bar.

Dr. Coolidge Announces 900-000-V. Cathode Ray Tube

IN RECEIVING the Edison Medal from the American Institute of Electrical Engineers for his work on lamps and X-ray tubes, on Feb. 15, Dr. W. D. Coolidge of the General Electric Co. announced the latest product of his researches, the triple cascade cathode ray tube, operating on 900,000 v. and capable of sending out into the air a stream of electrons with a velocity of 175,000 mi. per sec.

At the Franklin Institute, three years ago, Dr. Coolidge announced the first cathode ray tube, which operated at 300,000 v. Since that time he tried building larger individual tubes but found limitations to the voltage which could be used. He then tried out the cascade arrangement used in the present tube whereby the rays from one tube are fed into another which would speed them up and feed this highly accelerated ray to still another tube. In this way he developed the 900,000-v. tube.

Electrons expelled from this tube are projected at the rate of 175,000 mi. per sec., the fastest speed ever accelerated by man. This cascade or multisectional system promises vacuum discharge tubes for as high voltages as can be produced. This applies to X-ray tubes as well as to cathode ray and kenetron tubes.

"This," says Dr. Coolidge, "opens up a vista of

alluring scientific possibilities. It has tantalized us for years to think that we couldn't produce in the laboratory just as high-speed electrons as the highest velocity beta rays of radium and just as penetrating radiations as the shortest wave-length gamma rays from radium. According to Sir Ernest Rutherford, we need only a little more than twice the voltage which we have already employed, to produce X-rays as penetrating as the most penetrating gamma rays from radium and three million volts to produce as high-speed beta rays. The intensity factor would be tremendously in our favor, as with 12 milliamperes of current we would have as many high-speed electrons coming from the tube as from a ton of radium in equilibrium with its decomposition products. Another factor in our favor would be the control which we would have of the output. This would be quite different from our position with respect to radium, in which case no physical or chemical agency at our command in any way affects either the quality or the quantity of the output."

Just what the high-speed electrons sent out by this new tube will be used for is still a problem. Eventually they should help to a further knowledge of radiation laws and of the nucleus of the atom. It is not unlikely that therapeutic, chemical, bactericidal and other practical uses will develop.

Power Transmission by High-Voltage Cables*

NEW OIL-FILLED CABLE OPERATING AT 132,000 V. IS A FEATURE OF THE CHICAGO UNDERGROUND TRANSMISSION SYSTEM. BY H. B. GEAR†

USE OF CABLES for the transmission and distribution of electricity was adopted very early in the development of electric utilities operating in the larger cities, for the very practical reason that space for higher voltage overhead lines was not available in closely built up districts. The experience of such utilities soon taught them that, though the first cost of underground lines was greater, their use in congested areas resulted in reduced maintenance costs and gave more dependable service through independence of weather conditions.

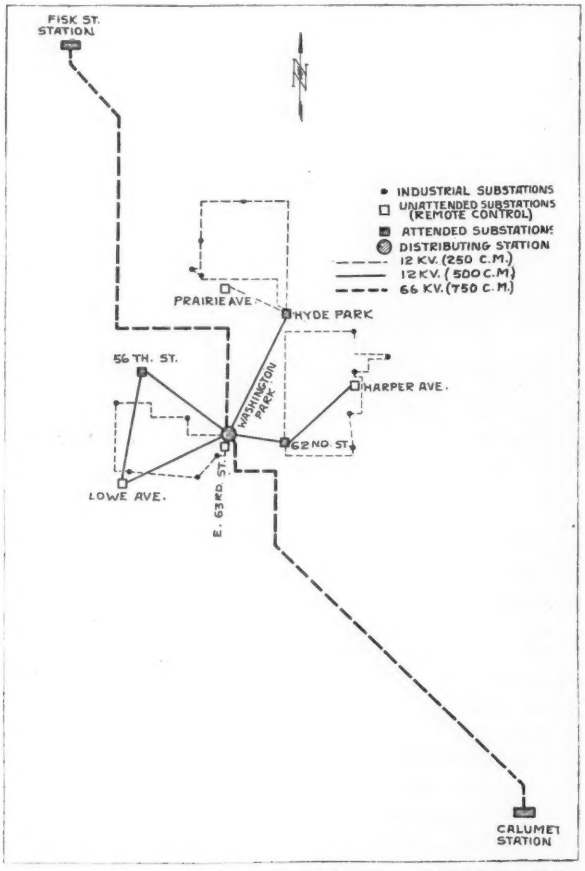


FIG. 1. RING CIRCUITS OF 4000 KV.A. CAPACITY FOR INDUSTRIAL USERS

In 1921 the transmission of 30,000 kw. or more, from the Calumet Station in South Chicago, to Fisk Street Station, demanded that a large cable unit be employed. A three-conductor, 350,000 circular mil cable was selected and it was arranged for operation at 33,000 v., which gave a circuit capacity of 15,000 kw. per cable. The existence of a conduit system having 3½-in. ducts, limited the choice to a cable having not over 3 in. outside diameter.

Five years later, the prospective development of a very large station at the Illinois-Indiana State Line and the development of large capacity at Crawford Avenue Station for transmission to other zones called for another increase in circuit capacity. This resulted in the selection of a 66,000-v., single-conductor unit, giving a circuit capacity of about 50,000 kv.a., the first of which went into service in the fall of 1926 between the Crawford Avenue and Fisk Street Stations.

Other circuits were laid in 1927, and it is expected that these will ultimately supplant the interstation cables originally laid for 33,000-v. service, which are at present operated at 22,000 v.

During the year 1927, six circuit miles of cable, operating at 132,000 v. were laid as the terminus of a 32-mi. tie between the Waukegan Station and the Northwest Station in Chicago.

This is one of two pioneer installations of this type of cable, the other having been made as a part of a line running north from the City of New York.

These circuits have a maximum rating of 90,000 kv.a., insofar as the cable portion of the circuit is concerned.

The 33,000-v. cables installed as tie-lines from Calumet to Fisk Street Stations were impregnated with a mineral oil compound and had a very low dielectric loss, even though the voltage stress in the insulation was higher than in any cables previously laid in Chicago. After eight to ten months of fairly continuous service these cables began to fail with increasing frequency, and it became necessary to reduce the working voltage to 22,000 to keep them in service.

Upon examination of the cables which failed, it was

*Abstract of a paper presented at the Midwest Power Conference.

†Asst. to President, Commonwealth Edison Co.

noticed that a waxy compound had been formed and that electric discharge had been taking place through the occluded gases in the voids. The exact nature of the formation of this wax and the generation of gases has not been determined, though it has had the attention of leading chemists and physical research experts.

In the 132,000-v. cable, the use of fluid impregnation is chiefly depended upon for insulation, since the thickness of the paper belt is but a little more than it is in the 66,000-v. cable.

The conductor of this cable, which is equivalent to 600,000 circular mils, is stranded around a central spiral core, having an internal diameter of ½ in. This core acts as a pipe to supply oil throughout the length of the cable, so that every possible space not otherwise occupied is filled with oil. This is insured at the time of

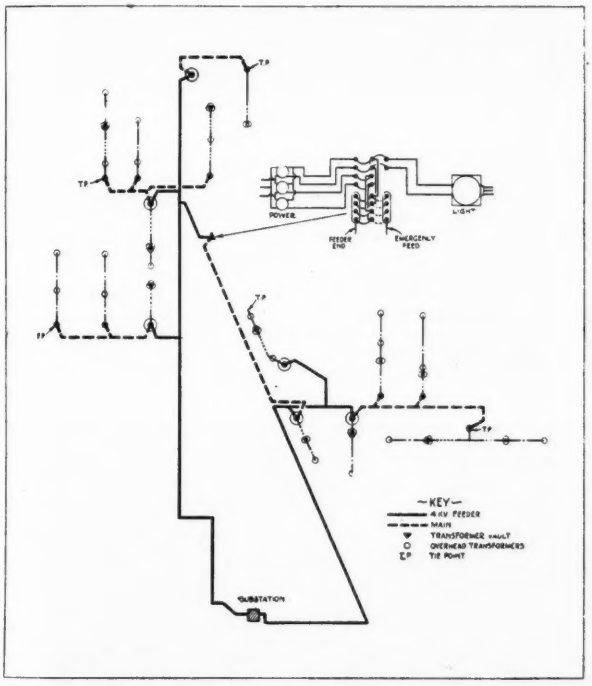


FIG. 2. RADIAL SYSTEM OF DISTRIBUTION FOR USERS TAKING 150 TO 450 KV.A.

installation by a vacuum pump, which draws out gases at one end, while oil is being pumped in at the other end. The supply is maintained by storage reservoirs at intervals of about 2 mi. These are so arranged that oil can leave the cable under the expansion incident to the heat liberated by the load current, and return to it as the temperature falls. A cross section of this cable is shown on page 333 of this issue.

Industrial Power Supply

Industries using power in blocks of over 500 kv.a in Chicago are supplied from cable circuits, except in a few cases on the far south side. The 12,000-v. transmission system is used, chiefly, for this purpose, thus combining this service with the line capacity used to supply energy to distributing substations.

Attended substations are supplied by radial circuits, having a capacity of 8500 kv.a. each.

Reserve capacity is made available to two or more substations through 12,000-v. tie-line cables, so arranged that when any main cable fails, the capacity of a reserve cable is promptly available.

Remote control substations are supplied from attended substations and are operated with the aid of pilot wires, which transmit indications of switch operations from the remote switchboard to the operator of the attended substation.

Industrial users are supplied by ring circuits, having a capacity of 4000 kv.a., which emerge from an attended substation, pass through the industrial transformer vaults successively and return to the starting point. (Fig. 1.)

A section of cable failing in such a ring circuit is automatically disconnected at each end, and (unless relay operation is faulty) the service is not interrupted to any user on the ring.

These ring circuits are further protected by reactors which act as a cushion for short circuits occurring anywhere on the ring and prevent the disturbance from being extended farther back than the substation, whence the supply is taken.

The larger cables, running from the generating station to main substations, are similarly protected by reactors.

The group of users taking from 150 to 450 kv.a. (which is much more numerous) is supplied from the general 4000-v. distribution system. This is a radial system, with practically all the feeder system and much of the branch main system underground.

Where space does not permit a pole installation of transformers, they are placed indoors on the user's premises, and this type of installation is rapidly increasing in number.

In such installations, emergency cable connections are brought from a neighboring circuit, and arrangements are provided by which the transformers can be transferred to the emergency cable quickly by means of detachable potheads and a switching table. (Fig. 2.)

It might be inferred from the foregoing outline of reserve facilities that, after all, cables were not so highly reliable.

Operating records, however, show that the average number of cable faults is about 2.5 per 100 mi. per year. The average line is less than 10 mi. long, so that the average line is interrupted by a fault only once in 4 or 5 yr.

A considerable part of the faults are due to external interference by excavations on sewer, paving or other causes beyond the control of the utility.

How much oil can a ring deliver? What is the best shape of its section? Why does oil occasionally leak out from bearings that are apparently perfect? These are a few of the problems studied by lubrication experts of the Westinghouse Electric and Manufacturing Co. In this type of bearing the oil is supplied by an oil ring which drags along oil from the well to the journal. The ring itself is driven by the journal on which it rides. This test reveals the fact that the ring never touches the journal but rides on oil. An electric light put across the journal and the ring does not burn because the oil between the two metal surfaces acts as an insulator.

Milk Products Machinery of Galloway-West Co. Furnishes Year-Round Process Steam Load for Well-Equipped, Isolated Plant

IN THE MANUFACTURE of milk products, as carried on by Galloway-West Co., Fond du Lac, Wis., in the neat, well-equipped plant shown below, a large amount of process steam is needed all year round. This makes it economical for the company to operate its own power and refrigerating plant as shown here, sending exhaust steam at about 5 lb. gage to the processes, in addition to heating the building in winter, and generating all its electric power as a by-product.

Alternating current is generated for motors throughout the mill and by care in loading these and the use of a few synchronous motors, the power factor of the plant is kept at about 92 per cent, at full load. Boilers are at present operating at about 280 per cent of rating.

M. E. West is president of Galloway-West Co. and Frank Ebert is chief engineer.

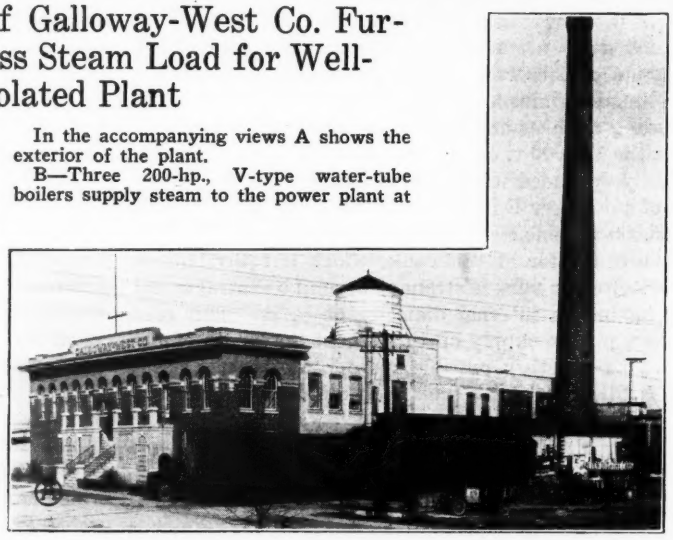
In the accompanying views A shows the exterior of the plant.

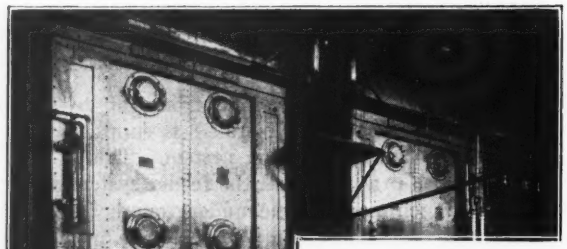
B—Three 200-hp., V-type water-tube boilers supply steam to the power plant at 150 lb. pressure. They are fired by underfeed stokers, forced draft being supplied by an engine-driven fan.

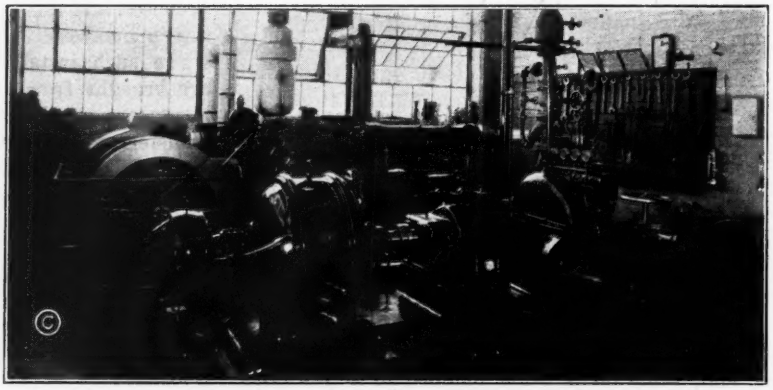
C—In the background is a two-stage, steam-driven air compressor supplying compressed air for the air lifts and for various industrial uses. In the foreground is a 100-kw., 240-v., a.c. generator driven through a reduction gear by a steam turbine.

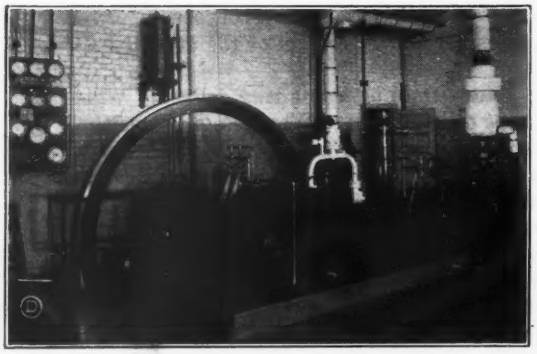
D—One of two steam-driven ammonia compressors providing refrigeration for process work.

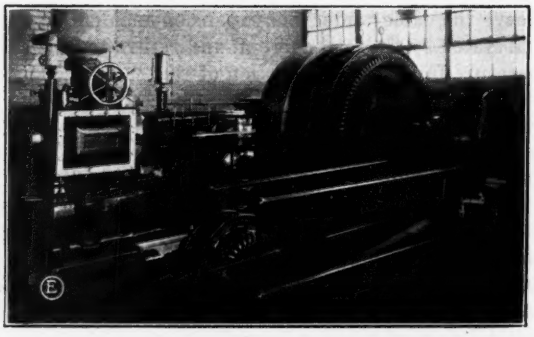
E—To take the larger part of the electrical load, this 250-kw., 240-v., a.c. generator is driven by a 17 by 22-in. single cylinder, slide valve engine.











Pan Prevents Sludge from Causing Bagging

PREVENTION of sludge settling on the bottom of horizontal tubular boilers and causing bagging, by the use of a mud guard described by James F. Hobart on page 199 of the February 1 issue, interested me.

We have used pans for this purpose many years with entire success. Any scale or mud finding its way to the fire sheet is automatically thrown up into the pan where

SLUDGE IS THROWN INTO PAN WHERE IT REMAINS UNTIL PAN IS CLEANED

it remains until removed by the boiler cleaner. Our boilers have 10 by 18-in. manholes under the tubes which enables us to use a pan about two in. deep, 12 in. wide, with two in. legs. They are equal in length to the fire sheet of the boiler. The pans are made of 20 gage galvanized iron; the legs are of 1½ by ¼-in. iron. It is better to have few small holes in the bottom so that when the boiler is emptied the pans will drain off the water, making a less sloppy job of removing them from the boiler. We have had a set of these pans in use at least 12 yr., so the cost is not much.

We always either specify handholes under the tubes in the rear heads so we can remove the scale and mud that gathers or may be washed there with the hose, also we had the handholes bored taper and plugs fitted in a press fit. These were tapped for a ¾-in. bolt, the tapping not reaching through. In this way we avoided turning of the threads. We also roll a piece of screen up and stock it in the blowoff opening; this prevents clogging of the blowoff pipe.

We have boilers 24 yr. old that have never had a tube replacement. We always try to avoid sudden changes of temperature so far as possible. When washed out they are filled with water of a temperature at least 140 deg. or more. Also, we try to have the dampers kept well closed when they are standing under a banked fire.

Anderson, Ind. J. O. BENEFIEL.

Lubricating Under Operation with High Superheated Steam

WITH reciprocating engines running on saturated steam, a source of lubrication in the cylinders is the moisture in or condensed from the steam. With superheated steam this is largely absent as moisture does not condense until the steam has been well expanded, and one of the arguments against the use of superheated steam in reciprocators was that this source of lubrication would be absent. With high superheats it takes a good lubricant to stand up to the temperature without being decomposed, and when temperatures approaching 750 deg. are reached few lubricants will give satisfaction. Moreover the lubricant is affected by changes in superheat, if for any reason the degree of superheat drops considerably the effect on the lubrication will be nearly as great as a change in lubricant.

With a varying superheat, efficient lubrication becomes impossible. On a reciprocating engine running on highly superheated steam a water jet was fitted to admit a water spray to the steam just before it entered the cylinders with a view to reducing the superheat. As an experiment the supply of cylinder lubricant was continually reduced, until it was found that with the oil shut off the engine ran smoothly, being perfectly lubricated by the water jet. There was no sign of excessive wear when the engine was subsequently dismantled. It is found that water takes a long time to evaporate in superheated steam, and in the case of an engine it is doubtful if any of the water added is evaporated and it seems as if it settles directly on the cylinder walls. The temperature of the steam was only slightly reduced. Subsequently it was decided to try lubricating with water to which a trace of graphite had been added, graphite lubrication having been used before in many cases with success.

To a quantity of pure distilled water was added ⅓ per cent of 99.8 per cent pure graphite in a very fine state of subdivision. The automatic lubricators were filled with this and were allowed to lubricate the cylinders in the ordinary way, this was found to be entirely satisfactory and to give equal lubrication to the best cylinder oil obtainable. Pure distilled water was used as the graphite entered into solution better, this water contained no solid matter which is not the case with moisture in saturated steam as impurities may be carried over from the boiler or collected as the steam flows through the pipes. The graphite powder used must be the finest obtainable, as this will remain in suspension in water for almost an indefinite period; the small quantity indicated is quite sufficient to ensure lubrication.

There is a considerable economy to be gained by utilizing the exhaust steam, and in many cases the great-

est objection to this is the trouble due to oil in the steam obtained from the cylinder lubricant. This is overcome by lubricating in the way mentioned; the small amount of graphite is not objectionable but this is largely taken up and worked into the cylinder walls and piston rings.

Brentford, England. W. E. WARNER.

Maintenance of Transformer Insulating Oil

FOR PURIFYING transformer oil, several methods are used involving transporting a truck-mounted insulating oil purifier from substation to substation at widely separated points and at each one circulating the transformer oil through the purifying equipment. To the practical man certain disadvantages are apparent in this process.

Practical experience has indicated that a better method consists of transferring 80 per cent of the oil in the transformer to a storage tank. The oil remaining in the bottom of the transformer should then be circulated several times through the purifying equipment.

The advantage of this method is that the oil splashes over the windings of the transformer, washing them of all tenacious asphaltic sludge.

Asphaltic sludge has a tendency to prevent a proper heat transfer from the copper to the insulating oil.

Naturally, the oil which has been drawn and stored during this process is returned to the transformer via the oil purifying equipment.

Experience gained from many tests has proven that 300 per cent more sludge can be drawn from the insulating oil by the use of this process. This indicates that the portable purifying equipment method is not so efficient.

Another practice that is fast falling into disfavor among the more modern power companies, is that of storing oil in the drums received from the refinery.

It has been shown that in many cases fairly good oil has been circulated, filtered and purified from one drum to another, only to be transferred to a drum containing the residue of many insulating oils, which has been overlooked due to the difficulty of inspecting a drum through the bung prior to use.

It has been found that there is greater efficiency in transferring the oil to a storage tank as soon as received and returning the empty drums to the oil refinery as soon as possible. Many power companies could install a good oil storage system from the deposit money reclaimed on the returned oil drums they are now using.

There seems to be some misunderstanding among maintenance men regarding the terms, "insulating oil storage tank" and "insulating oil reclaiming tank."

Shape and piping of an oil reclaiming tank depends entirely upon the type of purifying equipment which is intended for use. If a centrifugal purifier only is used, almost any shape of tank may be utilized as a reclaiming tank, if the inlet of this tank is at the extreme top of the tank and the outlet at the extreme bottom, as widely separated as possible.

If a filter press or blotter dryer is used, a cone shaped tank is far more efficient. This type of tank is shaped much like a funnel and allows a great proportion of the sludge, sediment and collected moisture contained in the oil to settle in the lower chamber. These impurities can be drawn off by closing the valve at the top of the chamber and opening the valve at the lower end of the settling chamber. The oil drawn off more than pays for itself in the fewer number of blotters it is found necessary to use and the elimination of the labor which would be involved.

An insulating oil storage tank is merely a tank of almost any shape, sealed by means of "breathers" which prevent hydrous air from entering the tank when the oil expands and contracts due to changes in temperature. The storage tank is used for storing pure insulating oil under the most advantageous conditions for maintaining dielectric strength for an appreciable amount of time.

In designing an oil purifying system for a large substation, the modern tendency is to keep the transformer insulating oil piping if possible a distinct and separate system from the piping used for oil circuit breakers. This helps greatly to eliminate the possibility of mixing these oils, something in which every substation maintenance man is greatly interested.

Newark, N. J. WILLIAM HALEY.

Speed Measurements Should Be Accurate

THE ARTICLE under the above heading, published on page 194 of the February 1 issue, reminds me of an occurrence along that line which may be of interest. A friend of mine who happens to be a manufacturer's representative received a letter from an engineer who was in doubt about his belt slip. He had read about slip and creep and how to measure them, but on applying the rules he found that there was no appreciable creep or slip in his belt. He wrote as follows: "We are driving a 36-in. belt, $\frac{13}{32}$ in. thick, on a 45½-in. pulley at 200 r.p.m. The driver measures 61 in. and has 150 r.p.m."

He applied the rule and found that the slippage amounted to only ⅓ of one per cent. He then asked if he misunderstood the directions. To his questions and figures the representative replied: "The resultant ⅓ of one per cent slippage is impossible of attainment in practice and especially if the load is anything like a normal one for a 36-in. belt. Unavoidable slippage, due to belt creep, varies from one and one-half to three per cent; we should think that in a belt $\frac{13}{32}$ in. thick it would be nearly if not quite two per cent. This unavoidable belt creep is due to the elasticity of the belt. Apparently, therefore, you have 'assumed' your r.p.m.'s. In a problem of this kind absolute accuracy is essential.

"To undertake to count the speed of a shaft with your finger or even with a speed-counter for a period so short as a minute is bound to be in error regardless of the care taken. The r.p.m.'s of your driver may be anywhere between 150 and 151. The same would be true of your driven pulley. If you will figure the speeds, using your own data, you will find that theoretically a 61-in. driver running 150 r.p.m. will turn the driven pulley 201.1 r.p.m. One revolution on a 61-in. pulley repeated during a 10-hr. run would make a considerable difference in the output of a plant.

"If you wish to do it as it should be done for abso-

lute accuracy, the speeds of your driver and driven pulleys should be taken simultaneously through a 10-hr. period with a speed counter attached to each pulley. From the total, the r.p.m. could be easily and accurately figured. We are very glad indeed to know you are interested in this matter of belt slippage. We have been urging users of belt to look into this matter for more than 20 yr. You are on the right track."

I have copied the above extracts from the letters just to show the keen interest that is being aroused in power losses due to belt slip and the enormous savings that can be brought about if everybody would just get together and make up their minds to cut out this needless slip and consequent waste. For example, in the above case, my friend estimated the loss per year to be $180, due to slip alone on a single belt. One portion of the above letter that should be especially borne in mind is that it is virtually impossible to make one pulley run 200 r.p.m., and its running mate to run "exactly" 150. You can't talk in "round numbers" like this and talk accurately. It would be more accurate to talk about "so many r.p.m. per 10-hr. day." Let's eliminate the guess work and get down to accurate figuring."

Newark, N. J. W. F. SCHAPHORST.

Inartistic Center-Punch Marks

A CENTER-PUNCH is a handy tool, but personally I dislike its use on the polished parts of an engine. It may be harmless to see every part that has been taken apart marked with a number of center-punch marks, but it seems that everybody wants to put one or two more so that at times it becomes confusing.

The worst I have seen was on a large motor coupling with 24 bolts. They had been center-punched from 1 to 24. I am sure that in that power house they had at least one set of figures and a set of letters; how much neater it would have been to use them. Of course you may say that when the motor is running no one sees it, but when it is stopped, to see all that "pecking" on polished faces does not reflect skill nor care.

Clarkdale, Ariz. CHAS. LABBE.

Increasing Air Gap Corrects Starting Troubles

NOT INFREQUENTLY it happens that trouble develops in electrical equipment for which a ready remedy cannot be found in the experience of the repairman or in the literature of the industry. Such a problem presented itself some time ago in starting a standard-make, 75-kw., direct-current, 112-hp., three-phase, 25-cycle, 440-v. motor-generator unit.

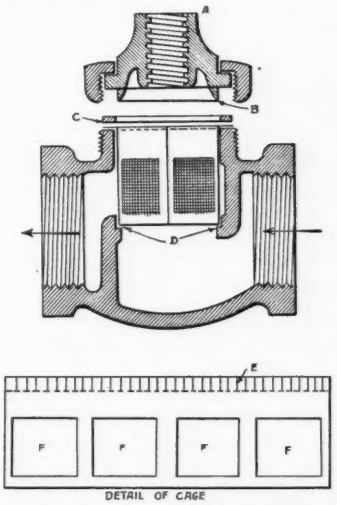
In the starting position, with the half voltage tap on the compensator, the motor took about 600 amp. or five times full load current. It barely turned over and chattered violently. The unit was of the two-bearing pedestal type with the base firmly grouted in. The alinement of the stator frame was adjusted by means of shims to secure an even air gap when the machine was at rest. When the unit was started the rotor apparently attempted to cling to the top of the stator iron. It was thought that the current distribution in the winding, which was a four-path star connection, might not be equalized. An ammeter in each circuit and an equalizer connection between pole-phase groups eliminated this possibility. Evidently it was essential to eliminate all possible vertical movement of the rotating element in the bearings, prevent any possible shifting of the stator frame and to investigate possible vibration of the shaft of the unit. After concluding this investigation and slightly increasing the air gap at the top of the stator as compared with the bottom, the starting performance was slightly improved; however, the machine would not come up to speed on starting and took about four times full load current of the starting position.

After consulting the manufacturers with regard to increasing the air gap, it was found that this could be increased 0.012 in. without seriously affecting the performance of the motor. A cut of 0.012 in. was taken off the rotor iron in a lathe and the machine reassembled. The machine then quickly came up to speed on the lowest tap of the compensator with a maximum starting current under two times full load current and showed normal performance as to heating at full load.

Woodward, Okla. HARRY J. ACHEE.

Strainer Made of a Valve

THERE ARE many places around the power plant where a strainer can be used to protect apparatus, such as on regulator pilot valves or thermostatic controls, small reducing valves, etc.

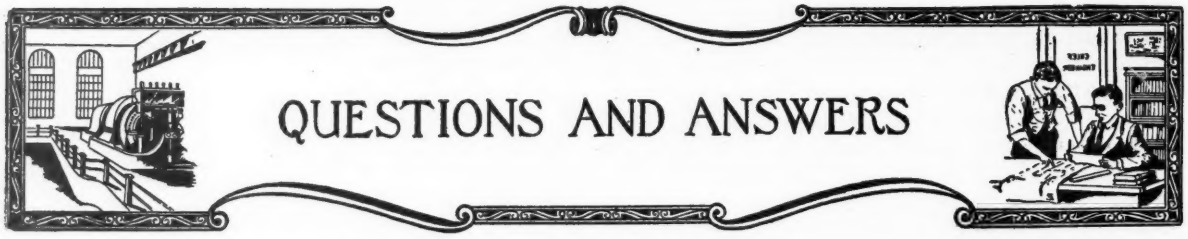


SLIGHT MODIFICATIONS CHANGE A WORN-OUT VALVE INTO A HANDY STRAINER

The accompanying sketch shows how I have made several strainers from worn-out valves. The blowoff feature can be eliminated and an angle valve can often be used in place of a globe type. The bonnet is cut off at A and tapped for pipe nipple for blowoff connection. Part B is removed and a flat seat formed to fit on bonnet. A rubber gasket is placed at C and the bevel seat of the valve removed and the part counterbored as shown at D.

Niches are cut in a piece of No. 20 gage brass from which a cage is formed, as shown at E, and these niches are bent over to form a flange. The squares F are cut out so as to permit the screen, which is placed on the inside, to function. After the cage is formed and fitted and the screen fitted, a couple of drops of solder on the inside will hold it in shape nicely.

New Haven, Conn. FRANK E. FINGER.



QUESTIONS AND ANSWERS

Drain Pipes Before Combining Steam at Different Pressures

IN CONNECTION with installation of a 1000-kw. bleeder turbine, we find it necessary to bleed steam at 200 lb. and 100 deg. superheat into a line carrying 145 lb. saturated steam. I would appreciate hearing from your readers as to whether or not this procedure involves any complications. The writer has been led to believe that superheated steam will combine with saturated steam without disturbance, drying out and raising the temperature of the latter; the possibility of hammering and internal disturbances, however, is disquieting.

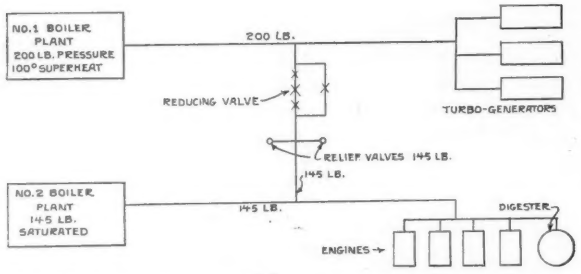


DIAGRAM SHOWING RELATION BETWEEN TWO BOILER PLANTS OPERATING AT DIFFERENT PRESSURES AND THE ENGINES THEY SERVE, SHOWING HOW STEAM IS BLED FROM THE HIGH PRESSURE LINE FOR THE LOWER PRESSURE LINE

Mixing superheated steam with saturated steam is, of course, unusual, therefore I will explain that we operate two separate boiler plants: No. 1 being equipped with superheaters and delivering steam at 200 lb. pressure and 100 deg. superheat; No. 2 boiler plant generates saturated steam at 145 lb. and the boilers are not safe for higher pressures. No. 1 plant supplies steam to turbines direct and also supplies steam at 145 lb. pressure through a reducing valve to the No. 2 header, which supplies steam to the several engines.

Assuming No. 2 does not generate enough steam to supply the 145 lb. demand, superheated steam is admitted automatically and flow continues until the pressure builds up. This procedure would normally be gradual, but we have an instantaneous demand at times for about 500 b.hp. for our digesters. Such a condition would call for a sudden pull on superheated steam if No. 2 happened to be running under light load at the time. A. P. N.

A. We believe your trouble is due to collection of condensed steam in the bleeder line, since this line is doubtless frequently deadended, at which time it is inactive. We would suggest introducing a steam trap or traps at all low points in this line so that there will be no condensate in the pipe when the steam from the superheat source is turned into the line. We shall be glad, however, to hear from our readers in regard to experiences with similar conditions.

Boiler Operation and Attention

PLEASE ASSIST me in the following questions:

1. What is the best method of removing thick scale from the tubes inside a Manning boiler? Would you recommend the use of kerosene?

2. How many B.t.u. and equivalent in coal is lost on the bare surface per square foot of a boiler carrying 110 lb. pressure with an atmospheric temperature of 75 deg.?

3. How can I put a hard surface on asbestos covering?

4. Is there any way of telling at what efficiency a boiler is running without charts?

5. The formula for figuring the safety valve area in state of Massachusetts is

$$A = \frac{W \times 70}{P} \times 11$$

What does the 70 represent? T. B. B.

A. If the scale is thick, it is best to remove the tubes, clean them thoroughly and return them.

If the scaled portion can be reached when dry, kerosene will help if it is sprayed over the surface. Kerosene has no chemical action on the scale; it merely penetrates between the scale and plate and loosens the scale but it may remain in place until the boiler is put under pressure. Therefore, when kerosene is used, the boiler should be shut down within four or five days and thoroughly washed out. If kerosene is used, care must be taken that there is no open flame in the vicinity.

We would advise having a chemical analysis made of the water to determine what causes formation of the scale.

2. Radiation losses from bare surfaces varies with the kind of surface and the temperature difference. From the drum of an uninsulated boiler carrying 110 lb. gage pressure and surrounded by an atmosphere at 75 deg., the radiation, according to a chart in the A. S. H. & V. E. guide, is about 3.17 B.t.u. per sq. ft. per deg. temp. difference per hr., or, taking the temperature difference at 270 deg. F., the loss would be 857 B.t.u. per sq. ft. per hr. With coal of 10,000 B.t.u. and boiler efficiency of 75 per cent, the coal loss per sq. ft. per hr. is approximately 0.15 lb.

3. A hard surface may be put on asbestos covering by covering it with canvas and then filling this with some filler such as Smooth-on and then painting it.

4. The approximate comparative efficiency of a boiler may be obtained by measuring the amount of

water and coal added between hourly periods and obtaining averages. The amount of fuel may roughly be obtained by counting shovelfuls; the amount of water by using a counter on the feed pump. These give only very rough approximations but may be used roughly for comparative purposes.

5. The value of 70 in the formula comes from the empirical formula on flow of steam developed by Napier whose approximate rule was stated as

$$W = (P \times A) \div 70$$

where

W = flow of steam in lb. per sec.
P = absolute pressure in lb. per sq. in.
A = area in sq. in.

Steam Plant Operation

REFERRING to answers published on page 263 of the Feb. 15 issue, I believe the answer to No. 1 should be essentially: If there is a partial vacuum in the receiver, it would indicate that the engine is underloaded. The remedy would be either to increase the load, if this be possible, or to decrease the initial pressure in the high pressure cylinder by lowering the boiler pressure. This will cause the engine to "live up to its load" with a longer cutoff in the high pressure cylinder and at some pressure above atmosphere in the receiver. Of course, this may not be economical but from the standpoint of good operation, it is probably the best to do under the circumstances.

Decreasing the cutoff in the low-pressure cylinder would build up a higher back pressure in the high-pressure cylinder, therefore causing an increase in the receiver pressure, throwing a greater portion of the load on the low-pressure cylinder. This would be just exactly what should be done in case of an overloaded engine but not in the case of an underloaded engine which is implied in the question by E. F. W.

With any engine there is a certain load that enables the engine to operate most efficiently and economically. When, for any reason, that load is changed in any considerable amount, something should be done to enable the engine to approach the ideal as closely as possible. The thing to do in the case under discussion is to increase the load or decrease the initial steam pressure.

Brooklyn, N. Y. CHARLES MASON.

Criticisms of Indicator Cards

REFERRING to the request for criticism of cards illustrated on page 263 of the February 15 issue, in the first place, the indicator piston spring (50 lb.) is too weak for the initial pressure of 150 lb. per sq. in., therefore the inertia of the moving parts of the indicator has caused the formation of erroneous figures.

All steam events, however, occur too early for the particular valve in question and the construction of its steam and exhaust ports. This means that the eccentric has been given too much angular advance. I would suggest that the angular advance be reduced at least 5 deg. This will decrease the lead at each end and also cause the other steam events to be retarded. Then a new set of cards should be taken using an 80 or 100-lb. spring.

Irregular back pressure lines as shown may be partly due to too early closing of the exhaust valve which may cramp the exhaust port opening and so cause the pressure to rise as indicated: They may be owing partly to inertia effects due to the abnormally light spring used.

Furthermore, the valve may leak and thus add to the distortion of the diagrams. It is necessary, therefore, to try several settings to see which gives the best results. The knocking which occurs when the eccentric is set at 90 deg. is probably due to not enough compression, owing to the late closing of the exhaust port.

Brooklyn, N. Y. CHARLES J. MASON.

IN ANSWER to W. J. M. for criticism of cards shown on page 263, at first glance I would say the admission was too early but after reading his statements, it appears that the eccentric is advanced 115 deg. ahead of the crank, which is too much. All events appear to be too early.

I would suggest that he set his eccentric 80 deg. ahead of the crank then take some more cards and adjust the eccentric to operate at the point at which the best results are obtained.

Too early admission has the effect of introducing excessive resistance to the motion of the piston, particularly near the end of the stroke and this will result in pounding. An engine running "under" will not run as quietly as it will when running "over."

Chicago, Ill. E. O. KIMMEL.

Low Pressure Turbine-Corliss Combination

WE HAVE in our plant two cross compound Corliss engines of 1000 hp. each, running condensing, each unit having its own condensers. We are purchasing electrical power amounting to about 900 kw. total capacity from a central station.

1. I am considering the idea of introducing a low pressure turbine, to furnish this electrical energy. Is such a project feasible from an economical point of view?

2. What is the usual water rate of a low pressure turbine? G. I.

A. Introduction of a low pressure steam turbine to run in conjunction with your present motive power would probably not be of sufficient economical advantage after installation to make it worth while. The Rankine cycle efficiency of your present engines compares well with that of a steam turbine operating under similar conditions. The possible gain would be due to the increase in vacuum from 24 in. under which you may now be operating to 28 in., which is possible in turbine operation. This small gain would not warrant the change you propose.

Introduction of a low pressure steam turbine under the conditions prevailing in your plant would necessitate operating the turbine between the pressure corresponding to atmospheric pressure and 28 in. of vacuum. Such introduction would also require raising the exhaust pressure of the Corliss engines, hence reducing their efficiencies.

The water rate of a low pressure steam turbine, operating between atmospheric pressure and 28 in. of vacuum, would be from 30 to 35 lb.

EDITORIAL COMMENT

Roseate Electricity

An increase of 86.6 per cent in the number of electrified farms during the three year period ending January 1, 1927, speaks well for the electrification campaign being carried on by the committee on the relation of electricity to agriculture composed of representatives of the Farm Bureau Federation, National Grange, Society of Agricultural Engineers, General Federation of Women's Clubs, Electrical Manufacturers Association, National Electric Light Association and the association of electric plant manufacturers.

In 1923 there were 165,000 electrified farms in the United States, while at the end of 1926 this increased to 227,500. Farms connected during the past three years are also more completely electrified, due to the necessary practical applications that have been developed.

In a typical newspaper story appearing in the New York Times, a rather pleasant picture is painted of one John Sanderson who owns a farm in Pennsylvania. After telling of the electric chicken houses, pumps, hay dryers and miscellaneous equipment, the article goes on—"Sanderson used to buy ground feed and run the risk of losing some of it when mold rotted it in his bins. Now he pulls a lever. Grain drops from a bin above into a hopper. He snaps a switch. You hear the purring of a motor and grain cracking in the grinder. The Susquehanna is working for the animals. Sanderson pays no attention to the grinder. He knows that the motor will stop automatically when the allotted amount of grain has been crushed, so he goes into the cow barn. Here he adjusts two milking machines to swollen udders. Back he goes to the grinder, which has finished its task. He switches the belt from the grinder to the suction gear that runs along the stalls in the cow barn. Presently you hear the swishing of milk in pails. The Susquehanna, seventy miles away, is milking Sanderson's cows for him—milking them better than he could milk them by hand."

Certainly such a story should cause any farmer to rush to the power company's office with his application for service or bring sighs from the poor $18 a week filing clerk in the city. Farm life has changed—yet we rather suspect that a farmer's life is still a farmer's life in spite of the benefits of electric power, and power companies must face facts in developing power customers among the farmers. A dairyman, who has made rather extensive use of the milking machine, mentioned that the young cows take to machines quite readily, but the old cows persist in their suspicions and hold back the milk. Thus the human race is not alone in its throwbacks of a past generation with their constant longing for the good old days and the company that will succeed in serving farmers is the one that recommends only those uses for electricity which will net a substantial return to the farmer either financially or in comfort and convenience.

Service Records Point to Needed Improvements

If you wish to know where the weak points in your mechanical equipment have been, take a look over your scrap pile. If you wish to know what these weaknesses have cost, you must go to your record of cost of repairs. This, however, does not give a complete story of the situation as the inconvenience and expense of time out caused by broken parts is seldom recorded.

For many years, we have advocated through these pages the use of records of plant equipment which would be virtually a ledger account for each important piece of equipment in the plant. Thus, there would be credited to the machines the hours of service and the load carried and there would be charged against it all expenses for keeping it in operation.

Such information is of inestimable value when it comes to the selection of new equipment and is a continuous guide in the choosing of supplies such as lubricants, packing, belting, gaskets, valves and other equipment which is renewed frequently.

Several years ago one of the large turbine manufacturers published data covering the service records of all their large turbine generators. This was a distinct service to the industry as well as a wonderful boost for the turbine generator. In this issue we are permitted to give the complete record of Diesel engines manufactured by one builder, which information we are sure will be eagerly received by engineers considering the installation of Diesel engines. It takes courage on the part of a manufacturer, in these days of keen competition, to make public such detailed information, but at the same time it sets an example which others must follow and the buying companies are beginning to demand some such record of other equipment.

Service records must originate with the users of the equipment and every detail of information which has to do with the serviceability of equipment should be recorded as an aid not only in the future operation of the equipment itself, but as a guide to the manufacturer in the improvement of the design of his products.

Keep Abreast of the Times

We never arrive at the point of perfection in power plant matters. We are glad of that fact for we know that it is in the running rather than in the finish of the race that most real interest is experienced.

The power plant industry is constantly changing. In power plant matters we find, however, too many persons who are willing to sit down complacently after their plant has been built and rest on their laurels, perfectly satisfied that their problem has not only been adequately solved but that it will remain solved.

Now methods and new equipment are constantly being introduced in the power plant field. It therefore

behooves every power man to keep himself thoroughly informed on new developments. Not only does benefit accrue from knowledge of new equipment but also from the ideas carried over that act as incentives to those who grasp them, to contribute to the state of the art. Does not any power man who confesses that he has not time to keep up-to-date in power matters and know what others are doing acknowledge his incompetence so to manage his affairs as to give most efficient service? Is he not plainly permitting his mind to be changed from the healthy plastic type to one that is calloused and set?

It is not wise to permit a plant so to run down that entire redesign and replacement become necessary nor is it wise, on the other extreme, to install every new device that is offered on the market as soon as it is introduced. A happy medium is arrived at when new devices and methods are noted and information collected until opportune time for introduction arrives.

Improvement in operating conditions usually follows wide awake adoption of new equipment and this, in turn, reacts upon the efficient operation of such equipment and arouses pride in maintaining the entire plant at its maximum efficiency.

Advantages to be gained by the introduction of up-to-date methods and equipment are illustrated in the article on Change in Boiler Plant Effects Large Savings, which appears on another page of this issue.

Off Duty

Strange things have been happening at Schenectady lately—strange, devilish things which, had they occurred in 1691, would have brought those involved to a speedy trial on charges of witchcraft. Indeed, were we not somewhat accustomed to the necromancy of the modern scientist, we might even today have suspicions as to the intimacy of the research boys at the General Electric Co. laboratory with Old Nick. For the sorcery of these D. Sc.'s and Ph. d.'s is such as would put a Merlin or a Cagliostro to shame. As a matter of fact, these old magicians of history were rank amateurs compared to the modern ones.

For when is it recorded that Merlin ever put a "weinie" into a test tube hung from a single length of wire and in a few minutes' time changed it into a beautifully cooked "hot dog" without the aid of fire, gunpowder or magic words? When was this old four-flusher of King Arthur's court ever able to pull an incandescent lamp from its carton for the first time and find it lighted to full brilliancy without wires or sockets? Of what avail would have been the prestidigitations of Cagliostro against such wizardry as this—the everyday technique of the modern electro-physicist? Picture your consternation in attempting to pick up a short copper bar lying on a concrete floor having it blister your hand, although the bar itself may be cold! Yet these and many other strange freaks of nature are everyday manifestations of a new high frequency radio tube recently developed by the General Electric Co.

This tube, which produces radio waves 6 meters long, has nothing new in principle but is different from previous short wave tubes in its tremendous power output—15 kilowatts at 50 million cycles per sec. It is a step in the development of short wave radio transmission and is connected through a coupling bar approximately 3 meters long, which constitutes the tuned aerial circuit and is able to radiate into space the full 15 kilowatts generated.

When they first began to experiment with this apparatus, work in other departments of the laboratory virtually came to a standstill. Meters in adjacent rooms ran wild, delicate measuring instruments were broken and twisted—indeed accurate scientific work was impossible. Men working near the apparatus noticed warming effects and subsequent medical observations showed that the blood temperature rose to nearly 100 deg. in about 15 min.

This latter phenomenon leads to interesting speculations. One's first thought is that this inner warming effect might successfully simulate the warming effects produced by prohibited stimulants. More seriously, however, if it is assumed that in this apparatus we have a perfectly harmless method for warming the blood, it might be of value in artificially producing fevers. Fever, or raised blood temperature, may well be one of nature's factors in recovery from infectious diseases. To maintain a fever, however, requires additional exertion on the part of the heart of the patient and in many cases his vitality is so low that it cannot maintain the necessary high blood temperature for a sufficient length of time. It is obvious, therefore, that if by the method suggested here the fever could be maintained artificially without any effort on the heart of the patient, the chances of recovery from such diseases as pneumonia would be greatly enhanced.

Some of the "stunts" performed with this equipment are of interest. A wire was suspended over a table some distance from the radiating aerial and parallel to it. A sausage, the weinie already referred to, placed in a glass test tube, was hung from the end of this receiving aerial and in a few minutes began to steam. On being removed, it was found to have been beautifully cooked by the high frequency currents induced in it. An apple, impaled on the end of the receiving aerial was similarly baked to the core in a short time.

Most striking of the short wave effects was the standing electric arc, a close imitation of the famous ball of fire reputed to accompany tropical thunder storms. In this case, the operator touched the end of the radiating aerial with a metal tipped pole, and immediately a greenish white arc arose to a height of a foot or more. When the pole was removed, however, the arc remained! There it stood, like a plume of fire, sputtering and sending molten copper in all directions until blown out. By skillful manipulation as many as three of these arcs were established at one time. No more extraordinary sight could be imagined than a powerful electric arc, representing thousands of volts, standing entirely by itself on the end of a wire without visible return circuit. Smaller arcs of this nature were established on the receiving aerial several feet away, demonstrating the transmission of power through space.

So, from sausages to broken meters, from baked apples to electric arcs this equipment presents many interesting new phenomena. What its practical application will be is too early to say and this does not particularly concern those that are experimenting with it. In the meantime it furnishes interesting material for Off Duty speculation.

Chicago Welcomes Third Midwest Power Show

FROM FEB. 14 TO 18, GREAT CHICAGO COLISEUM IS FILLED WITH EXTENSIVE EXHIBITS OF LATEST POWER PLANT AND INDUSTRIAL EQUIPMENT, VISITED BY ENGINEERS SEEKING LATEST DEVELOPMENTS

AT THE COLISEUM in Chicago, Ill., the third Midwestern Engineering Exposition, popularly known as the Chicago Power Show, was held from February 14 to 18. Extensive exhibits of interest to power and industrial plant engineers filled the main hall and the north and south wings of the great buildings. About 260 exhibitors occupied over 300 booths.

In the field of combustion, improved forms of unit pulverizers, pulverized coal burners and accessories were shown. A new underfeed stoker was displayed, and also a new small stoker for heating plant boilers.

Materials and methods for furnace construction attracted attention. One company displayed a new refractory gun, while several exhibited new types of furnace wall constructions, using water tubes with various types of protecting blocks. Exhibits of refractories in various forms, both block and plastic, drew the attention of the visitors.

Boiler manufacturers showed new types of header and drum construction for high pressures and temperatures. Two new air preheaters of the plate type and one of the regenerative type illustrated the most recent developments in this field. Reflecting the trend towards high temperatures and pressures, several new lines of valves and fittings aroused interest.

Among the material handling equipment, one outstanding feature was a weigh meter which recorded only the amount of pulverized coal or water actually taken from a hopper above it. New indicating and recording flow meters, a new dial type draft gage and a vertical draft gage, together with a new bi-metallic pyrometer, aroused considerable interest.

One of the principal features noted was the number of new unit heaters displayed by exhibitors, indicating the interest in this subject on the part of industrial engineers. Two unit air conditioners, new types of air filters for both industrial and domestic use and equipment for removing dirt from flue gas were also featured. Much interest was shown in a new type of forced and induced draft fan, driven at constant speed, the capacity being controlled by changing the amount of air admitted on the inlet side.

MANUFACTURERS' REPRESENTATIVES

Barrett-Christie Co., manufacturers' agent, showed the new Instant Float Control, made by the Instant Water Heater Co. for controlling flow of steam through the Instant heater in proportion to the water flow to maintain constant temperature.

Also at this booth Armstrong Machine Works announced a new special alloy used for the valves of its steam traps, while Kieley & Mueller, Inc., displayed the new combination Hi-Lo boiler feed system.

Burnham & Lindsey, manufacturers' agents, featured the new developments of three companies. New units with the gear and turbine built integral in units up to 50 hp. for pressures up to 650 lb., 800 deg. total temperature and 125 lb. back pressure were featured by the Moore Steam Turbine Corp. Vulcan Soot Cleaner Co. exhibited its new entirely enclosed head, designed so that the head can be disconnected and the element withdrawn without disturbing the riser pipe. Steam purifiers in actual operation under severe conditions were demonstrated by the Centrifix Corp.

At the booth of Himelblau, Agazim & Co. several new products were shown for which this company acts as agent. A new form of the Coppus heat killer, made by Coppus Engineering Corp., for quickly cooling the inside of boiler drums, was displayed.

A new gate valve, known as the Kelly Neway valve, made by The Kelly Co., was also shown here. This valve has recently been described in detail in these columns.

A new design of oil cooler and heat exchanger, made by O. E. Frank Heater & Engineering Co., Inc., was also exhibited at this booth. In this design both oil and water inlet and outlet connections are formed in such a way that the head can be removed for inspection of the tube bundles without breaking any piping connections.

Lehnco regulators, made by the Lehnco Regulator Co., were also shown here by working models. This regulator is intended to control a battery of boilers, supplying steam to a header, cutting in or out one or more of the boilers, depending on the steam demand from the battery.

Air filter cells as supplied with the Ace automatic self-cleaning air filter were also displayed. This filter is manufactured by General Air Filters Corp. and is designed to clean itself by flushing the filter surfaces with oil at predetermined periods.

A working model of the Short automatic pumping trap, made by the W. B. Connor Co., Inc., was exhibited. This trap is designed so that there is nothing inside the body of the trap except a float which actuates the mechanism on the end of the trap outside.

Himelblau, Agazim & Co. also announced that it was agent for Filtrators Co., Inc., which exhibited in a separate booth. Here were shown full size specimens of the Filtrator, an apparatus designed to prevent the formation of scale in steam boilers by introducing flaxseed emulsion into the feedwater.

A section of the Keseco gas-fired water tube heating boiler was also displayed by Himelblau, Agazim & Co. This is manufactured by the Sterling Engineering Co. and is a two-pass water tube boiler designed especially for gas firing,

In the same booth was also shown the McNeil vertical draft gage, a new product of Boiler Room Improvement Co. This new gage employs the same differential pressure principle as is used on the liquid level gage of the same company, except that no mercury is used.

Around the booth of Ernest E. Lee Co. were grouped exhibits of companies which it represents. Atwood &

Morrill featured its balanced pilot operated back pressure valve which operates on a 2-lb. differential and can be positively set to operate at any desired pressure.

S. X. furnace wall Design B and the Armor Clad water wall made up of cast-iron blocks cast on steel tubes were featured by the Drake Non-Clinkering Furnace Block Co. These metal blocks are cast directly on the tubes without strain or distortion, and when completed, offer practically a smooth flat surface.

New steel stoker construction and automatic cooling of chain grate stokers for preheated air temperatures up to 550 deg. F. were featured by the Illinois Stoker Co. New links are ground to size for length and the holes are bored.

Dexter valve reseating tools were exhibited by the Leavitt Machine Co. The gate supports have been changed to make the center feed pin adjustable when seat rings of the valve are not in line.

New valves for the control of both feedwater flow and excess pressure were demonstrated by the Northern Equipment Co. Both of these valves are in a single valve body, the first controls the excess pressure and the second, operated from a thermostatic regulator, controls the flow into the boiler. The orifice valves for condensate drainage control, Copes outboard ball-bearing valves, the new tripper type thermostat and one of the new tension type thermostats were featured.

At the booth of the Uehling Instrument Co., the new motor drive, which has replaced the aspirator for CO_2 recorders and indicators, was featured. This unit, which is built for 1/6-hp. motor for either 110 v. a.c. or d.c. circuits, will handle as many as six meters.

New all steel construction and Timken bearings were also featured here in a working model of an American ring coal crusher by the American Pulverizer Co. These features are now standard on their full range of machines from 15 to 72-in. sizes.

LATEST DEVELOPMENTS IN TURBINES, PUMPS AND VALVES WERE EXHIBITED

The J. W. Murphy Co. showed products of the companies it represents featuring time recorders of from 5 to 40 pens and a new tachometer generator made by the Esterline-Angus Co., the Ground-Ohmer, a self-contained instrument for reading resistance of grounds directly in ohms, made by Herman H. Sticht & Co., a high voltage time switch for voltages up to 6600, made by The States Co., and the improved Cochrane Corp. flow meters with a time recorder attached.

Carrick mercury actuated master controls were demonstrated by the Carrick Engineering Co. in connection

with its new visible electric indicator, a recent development designed to be illuminated from 110 or 220-v. lighting circuits.

In the booth of the Hays Corp. was exhibited its new motor-driven, water-operated CO_2 recorder and a full size boiler panel of new design containing a Cochrane flow meter, multi-pointer gage, steam pressure and temperature recorder and a triple recorder for CO_2, flue gas temperature and draft.

At the booth of Naylor Hickey Corp., Bundy Steam Trap Co. displayed a new ½-in. size of the Bundy steam trap, showing the knife edge bearings to reduce friction, use of monel metal for valve seats and discs and other features similar to the larger traps recently announced. At this booth a new line of steel case gages made by J. E. Lonergan Co. was displayed. Besides this, Locke Regulator Co. had a working exhibition of the new Locke regulator, a damper regulator combined with a balanced valve.

Statewide Engineering Co. exhibited the new Mallen flow meter in the booth of Nuway Boiler & Engineering Co., which will act as agent for it. This meter consists of a mercury manometer with a float riding on top of the mercury.

In an elaborate, attractively decorated booth, furnished in blue and gold, D. H. Skeen & Co. displayed the products for which it acts as agent. On its regulator, Mercon Regulator Co. called special attention to the new construction of the mercury pot to eliminate leakage. This is now made from a single tube, the ends brought together and pressed down with only a small weld around the hole in the top.

Henszey De-Concentrator Co. had the actual heat exchangers of the Henszey system of continuous blowdown in which the amount of blowdown is controlled so as to be proportional to the load on the boiler.

The Allen-Sherman-Hoff Co., by a scene-in-action, showed a new system by which ash is conveyed to an elevated tank by the hydrojet system.

Several new valves made by the M. W. Kellogg Co. were displayed. One of these, a parallel slide gate valve of 10-in. size for 400 lb., 750 deg. operation was shown in operation by air or electric motor. On the Dean swing gate valve which was also exhibited, a new type of air motor was shown with a new limit switch construction.

The Edward Valve & Mfg. Co. displayed a large 10 by 12 cast steel non-return valve designed for 900 lb. pressure operation with ball bearings and other features. This is to be installed at the new Powerton Station.

A heating element from a Ljungstrom air preheater, taken from the Narragansett Station after two years of service, was displayed by Air Preheater Corp. to show the freedom from corrosion at the end of this time.

Several new tools for applying Apexior to the internal tube surfaces of water-tube boilers were displayed by The Dampney Co. of America.

The Tri-Lok Co. called attention to its new construction of safety steps for boiler house stairways and industrial plants. The nose of these stair treads is designed for visibility and is provided with friction grips.

The non-segregating coal distributor, made by Rolland-Gardner & Co., was also shown here. This distributor, constructed in the form of a segment of a cone cut by a vertical plane, is designed to allow the coal to be distributed uniformly across the full boiler width without segregation of fines and coarse particles.

A new system of standard wall tiling, known as Porstelain, to be sold by D. H. Skeen & Co., was demonstrated. This consists of pressed steel tiles with enamel finish mounted on an insulating base or groove foundation sheet with special cement to form a surfaced wall.

Stannard Power Equipment Co. displayed at its booth one of the new portable pumps of American Steam Pump Co. known as type MEP. This consists of a standard American-Marsh large capacity centrifugal pump, built to discharge in any direction by turning the pump casing, mounted on a channel iron truck with a steel housing to protect it, together with a gas engine which drives it.

This company is also agent for Nash Engineering Co.; one of the principal features of interest shown by the latter was the new Jennings suction sump pumps, of which two models were shown, one for clear water, in capacities to 30 g.p.m. and one for sewage, made in capacities from 30 g.p.m. to 800 g.p.m.

Combustion Equipment

The King Coal Model B stoker, designed especially for small boilers, was the principal item of interest at the booth of Joseph Harrington Co. The Model B stoker is for firebox and sectional boilers with furnaces 36 to 60 in. wide and requiring stoker capacities of 100 to 600 lb. of slack coal or screenings an hour.

The Auburn automatic fireman, a new type of underfeed stoker displayed by Auburn Stoker Corp., was shown in operation.

Combustion Engineering Corp. showed the new Couch adjustable type pulverized coal burner. The new S type air preheater, as recently described in these columns was shown and for the type E stoker a new form of rocker bar was demonstrated. This new bar is designed to give more even distribution of the fuel. The principal feature of the display was the large panel showing enlargements of tables of pulverized fuel plants taken from a recent N. E. L. A. report and shown, by means of red check marks, the particular equipment of Combustion Engineering Corp. that was used in each of these plants. Data on the Sulzer system for the dry quenching of coke and on the K S G process of low temperature carbonization were also presented by means of bulletins,

Working installations of Bethlehem-Dahl oil burners were exhibited by the Bethlehem Steel Co. in connection with a glassed in chamber to show the burner action. These burners, capable of developing from 25 to 300 hp. in the same burner with air or steam atomization, take 1¼ per cent of the total steam consumption for steam operation.

Foster Wheeler Corp. featured the new Foster water wall with bare tubes backed up by cast-iron blocks held in place by lugs welded onto the tubes, and the new Foster sectional air heater.

An automatic stoker known as the Modern coal burner was exhibited by the Modern Coal Burner Co. This stoker was designed primarily for apartment build-

ings, hotels, hospitals, laundries, for boilers developing from 15 to 60 hp.

The 1928 model Unipulvo and the new circular vortex type pulverized coal burner were featured by the Strong-Scott Mfg. Co. The external driving gears have been replaced by totally enclosed speed reducer and a separating spinner installed in the separator, giving improved separation of the fines and returning oversized particles back to the rotor with a minimum recirculation.

Furnace Construction and Refractories

Furnace Engineering Co., Inc., showed specimens of the Drake armor clad wall for furnace side walls and furnace floors.

Quigley Furnace Specialties Co., by photographs and data called attention to the new Quigley Bitumen gun designed for applying tar, asphalt or similar products to various surfaces, as recently described.

Plibrico Jointless Firebrick Co., in the Plibrico Theater set up in its booth, showed an interesting motion picture entitled "Escapes on Land and Sea," and another, "Fighting Furnace Failures."

A section of the new Bernitz Thayer water-cooled wall was featured by The Carborundum Co. as one of the latest uses of Carborundum brick. They also exhibited their non-perforated air-cooled wall with interlocking tongue and grooves for pulverized coal or oil burners.

THE WIDE VARIETY OF PRODUCTS EXHIBITED IS ILLUSTRATED BY THESE FIVE BOOTHS, COVERING PIPE BENDS, SPEED REDUCERS, SCREW ANCHORS, COAL HANDLING EQUIPMENT AND VALVES

Peabody Engineering Corp. exhibited specimens of its new insulated front plate for use with its pulverized coal, gas or oil burner. This is designed for use where preheated air is introduced to the burner, so as to allow the entire windbox front to be insulated.

A new refractory gun for applying plastic refractory to furnace walls was displayed in operation by the S. Obermayer Co. In this gun water and cement are put into a tank and thoroughly mixed by bubbling compressed air through them. Then a cap is put on the tank and, by applying air pressure, the refractory is sprayed through a nozzle.

The A. P. Green Firebrick Co. exhibited its super refractory, Big Chief, Mizzou and Kruzite as products of its new tunnel kiln which has increased its output of first quality brick.

In its exhibit of the Type A air-cooled unit side wall construction, the American Arch Co. featured its new clamp for use with a supporting casting and its new brick shapes which bypasses all vertical joints.

Thayer type walls and the type S-79 ventilated furnace floor were featured by the Bernitz Furnace Appliance Co. The Thayer wall is a water wall with Carborundum blocks clamped between the tubes. The venti-

lated floor is made of Carborundum blocks and is especially adapted to pulverized fuel and oil-burning furnaces, designed for air cooling.

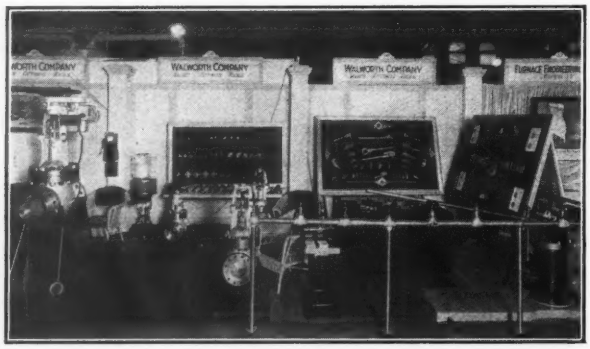
Vastine Sales Corp. featured its new Model M fire observers for water walls. A unit was shown mounted on fin tubes. The fins are cut away and the fire door mounted on a special casting. It also exhibited for the first time its locomotive observer and the Model IN ignition observer for use with chain grate stokers.

For use with the Bailey water-cooled furnace wall, glass inspection doors were shown by the Fuller Lehigh Co., who featured a display of drawings and photographs of new industrial and central station installations.

New commercial forms and applications of monel metal, especially of bolts, bus bar connectors, transmission line hardware and new designs of furnace refractory lining bolts were featured by the International Nickel Co. in their comprehensive exhibit.

Combustion Control Equipment

The new electric type of combustion control system was shown by the Hagan Corp. The motor-operated



ONE OF THE MANY EXHIBITS OF VALVES AND FITTINGS

regulating devices were mounted on panels and in actual operation.

The Bal-Draf Mfg. Co. displayed working models of its new balanced draft system for controlling operation of both heating and industrial plant boilers.

Miles automatic electric controls were featured by the Miles Engineering Co. in working exhibits covering a number of power plant applications. This control consists of an automatic switch and actuating device which controls the master power unit with a motor and speed reducer.

Under designation Type 70, the A. W. Cash Co. featured its new steam pressure regulator for dampers, stokers, etc. This regulator, which will take and hold any position between closed and full open, is designed to operate with water, air or oil pressure. In addition the company exhibited its improved Class 3F water regulator for refrigerating plants.

Most prominent among the features of the Bailey Meter Co. exhibit was an operating exhibit of the Bailey automatic combustion control, set up to exhibit the new control drive, which is much smaller than the original model and better adapted to installation in out-of-the-way locations in the boiler room.

Turbines and Pumps

Thomas Pump Co. displayed a new automatic electric drainage pump made in capacities from 4 to 23 g.p.m. for draining basements, elevator and boiler pits and similar locations.

One of the new Worthington centrifugal pipe line pumps was displayed at the booth of Worthington Pump & Machinery Corp. This pump, to be supplied to the Magnolia Pipe Line Co., together with several others, has a capacity of 24,000 bbl. per day, against 350 lb. pressure.

Chicago Pump Co. called special attention to the new automatic alternator for duplex centrifugal pumps. This is a device that automatically shifts the operation from one pump to the other and back again at predetermined intervals. The company also featured the Condo-Vac, a new vacuum condensation pump.

At the booth of Economy Pumping Machinery Co. particular attention was called to the new lubricating system for bilge pumps. On the company's vertical centrifugal sump pump, attention was called to a new construction of the float switch mechanism, in which an arm extends from the float upward through a guide pipe to a crank arm which actuates the switch mechanism.

As a feature of its exhibit, Schutte & Koerting Co. had a specimen of its steam jet thermo-compressor. This is designed to raise the pressure of exhaust steam so that it can be used in industrial processes. A new type of diffuser steam purifier was also featured at this booth.

Fairbanks, Morse & Co. had on display the Fairbanks-Morse Price turbine pumps which it is now placing on the market. These pumps are designed for deepwell service, driven by Fairbanks, Morse vertical ball bearing motors and are supplied in sizes from 50 g.p.m. to 900 g.p.m. Here also was shown a recently developed type of ball bearing, motor-driven centrifugal pump, the type HAC clean air jacketed motors of the enclosed self-ventilating continuous duty type and the new double squirrel cage motor for starting without a compensator was also shown here. The two latter units were recently described in detail in these columns.

Ingersoll-Rand Co. had an interesting exhibit to show the action of the Kingsbury thrust bearing which is used on its pumps. One terminal of an electrical circuit was connected to the upper half of the bearing, the other terminal to the lower half, while a small electric lamp was placed in the circuit of the lower half. When the bearing was rotated rapidly and power applied to the circuit, the lamp failed to light, but when the bearing began to slow down and finally came to a stop the circuit was completed and the lamp was lighted.

The Terry Steam Turbine Co., by photographs and diagrams presented information on its new stoker drive using a Terry turbine wheel and reduction gear.

Murray standard turbines were featured by the Murray Iron Works Co. A complete turbine open for inspection was available to show construction and illustrate the use of the needle controlled nozzles.

Allis-Chalmers Mfg. Co. displayed the new Type SSU centrifugal pump recently described in detail in these columns. New types of line start induction motors, known as type ARX, were also displayed at this booth. Another type of large line starting motor, as installed in a new large central station, was also on display.

Electrical Equipment

At the booth of the Cutler-Hammer Mfg. Co. a control panel for motor-operated valves was shown, including the new CH tight-seating relay for high pressure valves. There was also a new across-the-line automatic motor starter, No. 9586-AAA, for 500-hp. motors and under. For ventilating systems, house pumps, office building work and so on, a new d.c. or a.c. automatic motor starter was shown. This consists of a U-Re-Lite mounted with a C-H starter, the whole enclosed in a steel cabinet.

High pressure type T.T.R. gang-operated disconnects were featured by the Railway & Industrial Engineering Co. The units operated were for 220,000 v., such as used for the Southern California Edison Co. and at Conowingo.

Fully enclosed fan-cooled motors with two internal and two external fans were featured by the Reliance Electric & Engineering Co. These motors are made from ½ hp., 850 r.p.m. up to 60 hp., 1800 r.p.m., sizes for 110 to 550 v., and are interchangeable with open motors of the same size, as they have the same mounting and limiting dimensions. They are all of the ball bearing type.

The I. T. E. Circuit Breakers Co., formerly known as the Cutter Electrical & Mfg. Co., in a large exhibit featured the new I. T. E. semi-automatic circuit breaker Type LL. This circuit breaker has solenoid switches, with non-closable on overload solenoid and a newly designed pilot light switch. A new dual overload U-Re-Lite with two instantaneous and three time limit coils especially designed for steel mill and power plant auxiliaries was shown.

Weston Electrical Instrument Corp. featured its new Model 44 electric speed indicator suitable for indicating instantaneously any speed. The indicating instrument or voltmeter can be calibrated in any desired unit. It also exhibited its Model 528 portable voltmeter, a small, self-contained unit which can be furnished for any voltage up to 600.

Piping and Valves

Henry Vogt Machine Co. displayed its new line of fittings and valves in the 1350 lb. standard in all types. It also showed by a scene-in-action picture the new 7 pass multi-tube ammonia condenser.

Attention was called at the booth of Everlasting Valve Co. to an improvement in the Everlasting valve. This consists of a new type of disc spring, No. 9 K. The 600 lb. pressure twin blowoff unit exhibited will also be made of forged steel for pressures up to 1500 lb.

Properties of Dialum and Hera alloys developed by The Lunkenheimer Company were demonstrated by means of four exhibits of disc and seat faces of gate valves which have been subjected to repeated opening and closing under identical operating conditions at 400 lb. 750 deg. F.

Crane Co. had on display several examples of its new forged steel valve line, designed for pressures up to 900 lb. per sq. in. at 750 deg. F. in sizes from ½ in. to 3 in. globe valves.

At the booth of The Chapman Valve Mfg. Co. was shown a 14-in. chrome nickel steel valve designed for 1350 lb. pressure, 1000 deg. F. total temperature. This was shown in operation, driven by the new Chapman motor unit.

On the Wing disc valve shown by G. M. Davis Regulator Co. various improvements in details were shown, such as modifications of the guards and construction of the valve so that it is open at both ends.

The Wellman supertest gate and globe valves in various sizes were shown at the booth of The Wellman-Seaver-Morgan Co. These are designed for pressures up to 1350 lb. per sq. in. and total temperature up to 900 deg. F. steam.

Geo. B. Limbert & Co. displayed a large cast steel reducing long radius L with Sargol joints. This unit measures 16 by 14 in. and was designed for 400 lb. pressure operation at the Zilwaukee power station.

Walworth Co. displayed a new roller pipe cutter made in sizes up to No. 3 and announced a new line of flat band brass fittings.

Consolidated Ashcroft Hancock Co., Inc., called attention to its new line of forged steel valves for pressures up to 1400 lb. per sq. in.

For oil and gas work M. B. Skinner Co. showed a new band clamp for welded joints. This consists of a brass band to be wound about the joint and held by a buckle, while a screw is provided to tighten the band. A new 6-in. service saddle for gas and water lines was also displayed.

Proper welds for high pressures and high temperatures were featured by The Linde Air Products Co. by means of a sectionalized header with several different types of joints. Nozzle reinforcements, welded inside and out, new type of swedge with a smooth gradual taper and a butt weld and an anchor were all shown.

Globack joints with spherical backs were featured by the Midwest Piping & Supply Co. These joints, built for 600, 900 and 1300 lb. pressure, have spherical back face on the laps of existing tongue and groove, male and female, VanStone or Sargol joints.

Featured in the exhibit of The Wm. Powell Co. was a new line of 125 lb. iron gate valves built in complete range of sizes from 2 to 24 in. The company also featured a new complete line of cast steel valves also built up to 24 in. and up to Series 135, built to standard A. S. C. M. specifications.

In a comprehensive exhibit of cast steel flange fittings, flanges, heavy oil malleable fittings, standard malleable fittings, flanged cast iron fittings, the Stockham Pipe & Fitting Co. featured its new line of steel fittings, ranging up to series 135. Fittings in various stages from the rough casting to the finished product were displayed.

Products of the new Pipe Bending Process which produces bends or coils with a uniform thickness of wall, small radius and circular cross sections, were featured by the Pipe Bending Process Co. Used in conjunction with welding, most unusual shapes and assemblies can be made.

Full size cut away models of throttle, stop and check valves were shown by the Dri-Steam Valve Sales Corp. to demonstrate the action and purpose of Dri-Steam valves. A new locomotive valve which fits in the steam zone and delivers dry steam to the cylinders or superheaters was featured.

Jenkins Bros. featured an 8¼ by 10-in. forged steel drilling valve for 2500 lb. working pressure. This valve

which weighs but 1175 lb. was tested to 4000 lb. pressure with white kerosene without showing leakage.

Valve-reseating tools designed to be used with the new Crosby nozzle type safety valves were demonstrated in the booth of the Crosby Steam Gage & Valve Co. This reseating tool is designed to be used with the safety valve in place on the boiler. The bonnet is removed from the valve and the valve reseating tool clamped in place.

Core cells of a new design for high temperature pipe covering were featured by Weber Insulations, Inc. This is a combination of air cell and Weber's insulating paste, can be made any thickness and will withstand heat up to 1100 deg. F. without losing its efficiency.

Thermostatic control of temperature by means of a new electro-chemical valve was featured by the Johnson Service Co. This valve can be used in connection with either Sylphon or bi-metal thermostats, operates directly off 110 v. lighting circuit or on a 10-12 v. circuit; the working element is of Sylphon bellows with electrical resistance, and a Mercoid switch.

Steam Traps

Sarco Co., Inc., showed models of its new type FT combination float and thermostatic drip trap. Air is discharged from the trap by a thermostatic element independent of the float actuated valve which discharges condensate. The new trap is made in capacities up to

IN THIS GROUP OF EXHIBITS PRODUCTS RANGED FROM BALL BEARINGS AND DRAFT GAGES TO PIPING, VALVES AND BREECHINGS

A particular feature of the Foster Engineering Co. exhibit was a 6-in., all chrome steel, non-return stop valve, one of a complete line of all chrome steel valves being built for superheat temperatures up to 800 deg. F. These valves are made of Noncorrodite, a new alloy of high chromium.

Production control research and service methods were featured by the Reading Steel Casting Co. by means of a complete series of pictures. In addition they showed large motor operated valves representative of the complete line of valves which they now build in a full range of sizes up to series 135.

1000 lb. per hr., and for pressures up to 10 lb. per sq. in.

Wright-Austin Co. displayed the new Airxpel bucket trap designed in such a way that any air entrapped with the condensate is forced to the discharge tube of the trap so that it will be eliminated ahead of the condensate the next time the trap operates.

Sterling Engineering & Mfg. Co. exhibited a working model of the Sterling non-tilting lifting return trap and featured its new Fig. R-1 and R-2 and Fig. R-6 and R-7, in which the construction has been changed to eliminate the pipe fittings by the use of baffles.

Metal bellows of monel, bronze and brass were shown

by the Cook Electric Co., who in its exhibit showed not only the bellows themselves but the welding irons and equipment with which they are made.

Warren Webster & Co. displayed the new Webster drip trap designed for maximum working pressure of 10 lb. per sq. in. designed as a heavy duty trap for steam heating systems. The new Webster Series 78 thermostatic traps for process steam pressures were also shown, as recently described.

Feed Water Control and Treatment

The recently developed Type "S-V" differential valve for boiler feedwater control was shown by The Swartwout Co. This valve, a modification of the S-C Type S valve, includes an auxiliary mechanism designed to increase the pressure drop across the feedwater regulating valve as the load on the boiler increases.

In addition to a small scale 100,000-gal. upward flow water softener, Paige & Jones Chemical Co. featured the Paige & Jones feeder developed to feed its boiler water treatment which is put up in molded balls each weighing 1 lb.

In the booth of the Chicago Chemical Co. a new demonstration showing the effective use of sodium aluminate in conjunction with lime and soda ash for exceptionally hard water was featured.

In the booth of the Refinite Co. a new semi-automatic domestic water treater with a one-piece drop forged tank was featured. This is a new development for smaller size plants and, as with their other units, is used in connection with Refinite for softening.

Heat Exchange Equipment

The Leach fracto control condenser and heat exchanger, designed particularly for oil refinery service, was displayed by C. H. Wheeler Mfg. Co. This condenser provides means for close separation of several distillate fractions, allowing for adjustment and control of the cooling mediums in various vapor compartments.

Marion Machine Foundry & Supply Co. showed drawings of a Marion Gulf Stream water heater of extremely large size, designed to handle 30,000 g.p.h. of water for industrial purposes.

Henry Pratt Co. called particular attention to a new type of the Phillips condenser expansion joint known as the spring pressure plate type. The unit was designed for small clearance between prime mover and condenser. Particular attention was also called to a picture of a new Phillips expansion joint 16 ft. 6 in. inside diameter. Two of these, which are stated to be the largest expansion joints ever made, were designed for the new 165,000-kw. unit being installed at the Philo plant.

Griscom-Russell Co. showed quarter scale models of its new Tubeflo section. This is designed primarily for use in the oil industry and is of semi-steel construction designed to resist corrosive action of the material to be handled.

Oil and Steam Purifiers

Andrews-Bradshaw Co. exhibited the new Pipe Line Tracyfier, recently described in detail in these columns. This employs the same principles used in the Tracyfier for boilers, and is designed to remove moisture and dirt from lines carrying steam, air, gas and vapor.

A full size unit of the Nugent improved triple bag oil filter, Fig. 970, was in operation in the booth of Wm. W. Nugent & Co. Oil and water mixture was delivered to the filter to show the method of separation, the construction and operation of the triple filter bag and the automatic overflow alarm which notifies the engineer when the bags are dirty and need to be cleaned.

Power Plant Equipment Co. had on display new models of the Marley steam purifiers designed for installation outside the boiler. It also called special attention to the new louvre post construction for the Marley spray pond louvre fence.

Boilers and Auxiliaries

At the booth of The Superheater Co., a section of the new eccentric header for Elesco superheaters was shown. This is designed for operation at 1400 lb. per sq. in. pressure. Its principal characteristic is that the header is bored eccentrically to give more metal on the side on which the superheater tubes enter.

At the booth of The Casey-Hedges Co. the principal item of interest was a new forged steel sectional boiler header designed for high pressure operation. The handhole plate is in three pieces of forged steel, consisting of the plate and bolts of integral construction, a cap and a nut to hold the entire assembly together.

Blaw-Knox Co. exhibited a small working model of its air preheater. This operates on the regenerative principle in such a way that the heating elements in the preheater chamber alternately collect the heat from the waste gases and transfer that heat to the incoming air.

Diamond Power Specialty Corp. demonstrated the insulating effect of soot by means of a small electric plate with beakers of water insulated by soot and asbestos. It also showed an exhibit of 15 samples of various deposits taken from the tubes of coal and oil burning boilers.

The Babcock & Wilcox Co. in a very extensive exhibit, featured a 1400-lb. header, an actual section of a high pressure Stirling boiler drum and a 1400-lb. return bend economizer. In this design the bends are entirely outside of the wall to facilitate removal and cleaning of tubes. In addition there was an extensive display of B. & W. firebrick in standard and special shapes and samples of Enduro and Toncan iron tubes.

Sections of the breeching which will be installed in the Powerton Station of the Super Power Co. were shown in the booth of Connery & Co., Inc. This section was complete with dampers and expansion joints. In addition were exhibited sections of new designs of major expansion joints sectionalized to show construction.

New 1500-lb. equipment was featured by the Walsh & Weidner Boiler Co. by means of its new flat type water column gage glass and forged steel headers. It also showed a full size section of their new water wall furnace construction and pieces of new straight neck nozzles designed for high pressure construction with inside.

Meters and Other Instruments

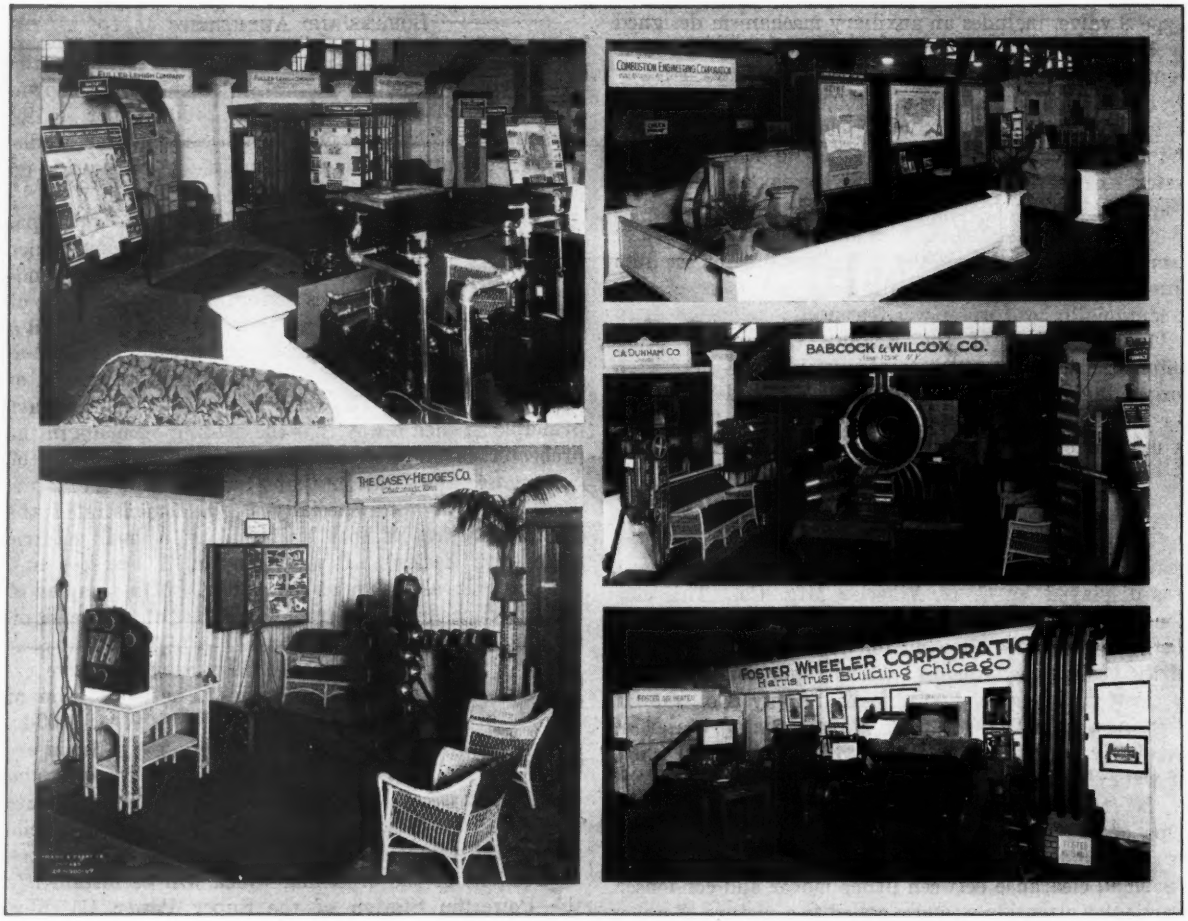
Yarway floatless Hi-Lo alarm water column equipped with a Yarway-Sesure inclined water gage was shown

in several models by Yarnall-Waring Co. This alarm depends for its action upon the displacement of solid weights, suspended from opposite ends of two balance levers within the column. A model of the Yarnall-Waring spray pond was shown in operation, special attention being called to the new louvre fence construction permitting easy removal or replacement of the louvres.

The Foxboro Co., Inc., showed its new improved flow meter with improved integrator construction and new design of main shaft and elimination of stuffing box so that the shaft is tight for 1200 lb. pressure. The manometer has been redesigned and an automatic float arrangement prevents overflow of the mercury.

under pressure or vacuum was featured by the Bristol Co., who also exhibited its new four-pen temperature recorder and their new temperature control recorder built with two actuating mechanisms, one for the recording pen and the other for the temperature control.

In addition to showing its New Type M Model C Venturi indicator, integrator and recorder and the new Type F cast steel Venturi nozzle, a new compacted form, the Builders Iron Foundry featured the new shunt meter. This meter is simple, has a low first cost, and an unusually wide measuring range of from 10 to 150 per cent of the rated flow with a guaranteed accuracy of plus or minus 2 per cent.



BOILERS AND SUPERHEATERS MADE INTERESTING DISPLAYS

For use where only one draft gage is needed for a boiler, or where a dial type gage is preferable, Lewis M. Ellison has brought out a new model draft gage of the dial type. This gage employs the same gasometer bell and beam principle as used in the straight line movement of this company, except that the larger pointer is allowed to swing over a dial instead of being transformed into a straight line movement.

Republic Flow Meters Co. showed specimens of its new expanding bi-metallic pyrometer element. Various bi-metallic combinations are used to meet the particular conditions encountered.

The Liquidometer, a liquid level recorder for tanks

The Permutit Co. featured the Ranarex CO_2 recorder, mounted so that it swung from side to side to demonstrate reliability and practicability for marine work. It was set up to show important changes made in the gas filter system. A porous thimble is now used in the last pass and in addition a steel wool filter is inserted before the instrument.

An Xacto meter in actual operation under conditions similar to those found in industrial plants was shown by S. F. Bowser & Co., Inc. This meter consists of five pistons actuating a wobble plate and is a positive displacement meter with a guaranteed accuracy of ½ of 1 per cent, designed for use with all liquids.

Coal and Ash Handling Equipment

A new type of sheave block, designed particularly for drag scrapers and slackline cableways was displayed by Sauerman Bros., Inc. These sheaves are made of heat treated alloy steel and are supplied either with bronze bushed bearings or with Timken roller bearings, as desired.

At the booth of American Blower Corp., four models of the new Sirocco dust collector were shown in operation. These were set up so that dust could be introduced and sent through them for testing. Besides this, the company's air filter was shown in operation.

Barber-Greene Co. featured by means of models its new coal car unloader built with a platform 3¾ in. thick for unloading hopper bottom cars. The unit is equipped with a 5-hp. motor and has a 2-speed adjustment.

Merrick mechanical Weighman for weighing pulverized coal, liquids or other hopper handled material, was featured by the Merrick Scale Mfg. Co. This is built from 20 to 50 t. hopper sizes with guaranteed accuracy of ¼ of 1 per cent and weighs the material as it leaves the hopper so that any coal sticking into the hopper or spilled before it is entirely empty, would not register, the scale indicating only that removed.

Steam jacketed cast-iron crank cases, to prevent freezing were featured by the United Conveyor Corp. The design is such that they can be installed the entire width of a hopper, allowing the hopper to be entirely emptied.

A full size apron feed automatic crushed coal scale of the type to be installed in the State Line and Powerton stations were exhibited in operation by the Richardson Scale Co. to show the method of weighing coal used by each individual boiler.

Fans and Blowers

Buffalo Forge Co. called attention to the new Buffalo volume fan, a model of which was displayed, a new non-clogging raw sewage pump and, of interest to heating engineers was the new Buffalo Type AA unit heater, a model of which was displayed. This is a floor type high pressure unit, designed to recirculate the air. A new type of Universal iron worker, to meet the need of shops requiring large capacities, was also demonstrated.

In its exhibit of fans, tubular air preheaters with lead coated tubes, multi-stage blowers, blowers for household furnaces, Windovane fans for household ventilation and unit ventilators, the B. F. Sturtevant Co. featured its new Type I. D. Turbovane fan with vane control. These fans are driven by a constant speed motor and the volume controlled by vanes in the inlet box which also serve as guides to deliver the air to the vanes.

Heating and Air Conditioning Equipment

Reed air filters for air compressors, oil engines and pneumatic equipment were shown by Reed Air Filter Co. Here also was shown Circulair, a new type of convection heater designed to replace cast-iron radiators in steam and hot water systems. There was also shown a small unit humidifier for domestic heating systems and the Reed furnace filters designed for application to domestic warm air furnaces.

Grinnell Co. called particular attention to the new unit heater known as the Thermolier, displayed at its booth. Seamless copper U tubes with separate brass fins are placed horizontally in the heater with the fins vertical to provide for self cleaning. The frame is of heavy pressed steel. The unit is designed to heat floor areas from 500 to 5000 sq. ft., depending on conditions and can be under individual or group control, either manual or automatic. Besides this the company's new Triple line of piping and fittings was shown in an attractive display. This includes material for 400, 600 or 900 lb. working pressure.

At the booth of Aerofin Corp. was shown the new high pressure Aerofin. This is a compact light weight encased unit, fan system heating surface. The unit is designed for operation at pressures of not less than 25 lb. gage and not more than 350 lb. at 500 deg. F.

Carrier Engineering Co. also showed several models of the Circulair, which it has developed and which is manufactured by Reed Air Filters Co. The new unit air conditioner recently developed by this company was also shown. This is designed for humidifying, heating, dehumidifying, cooling air washing and circulation for all types of industrial applications.

National Air Filter Co. showed an operating model of the Dri-drum air filter, a recent addition to its line. This is designed for handling certain types of dust or fluffy linty fibrous material in industrial process, such as paper, textile, or cordage work. The company also displayed several types of filters for air compressors and the Airmat cabinet filter. In this filter, units are made up of sections containing a special fibrous product laid in plies which allows air to pass through but retains dirt.

The Herman Nelson Corp. displayed its new wedge core radiator sections with extended surface, as used in the Univent heaters and for other applications. The new invisible type of radiator using this wedge core surface and designed for residences or fine buildings was also exhibited. For use with unit heaters the Hernelco motor was displayed. By means of a transformer used in connection with this motor and the changing of leads in the transformer, the speed of the motor can be varied.

Sub-atmospheric reducing valves were featured by the C. A. Dunham Co. These valves are used for pressure control under vacuums as high as 25 and 26 in. and are built in a complete range of sizes from ¾ to 12 in. They also exhibited a differential vacuum pump with a new kinetic exhauster and new impeller design.

Brass radiators made with a continuous butt weld on brass were featured by the Rome Bass Radiator Corp. They are but 20 per cent the weight of cast iron radiators of the same surface. In addition was exhibited a 750-w. electric steam unit heater. Electricity generates steam which is radiated through 28 sq. ft. of radiation surface.

Applications of the Wing feather weight unit heater in a factory building of the General Electric Co. were illustrated in a large colored photograph by the L. J. Wing Mfg. Co. In the photograph polished nickel heater models were inserted.

Working models of heaters were exhibited by the Modine Mfg. Co., which featured its new Recess heater which can be recessed in a 4-in. wall. Valves and

damper and piping are accessible and visible from the front and a humidifying pan at the top acts as both a deflector and humidifier.

Air testing and gas testing apparatus were exhibited by E. Vernon Hill Co. who featured the Aqua-Therm and the Duo-Therm, two instruments developed for determining the true comfort conditions of the air, based on both temperature and humidity conditions.

A new design of unit air conditioner especially adapted for industrial purposes was demonstrated in the booth of the Clarage Fan Co. by a working model. This is a self-contained unit requiring no duct work after installation.

Variable speed motor drives for heaters and unit heaters were featured by the Trane Co. in its complete exhibit of heating specialties, which included the new line of drip traps and a new damper louvre for installation behind the grill of heaters and heat cabinets.

Bearings, Packing and Miscellaneous Mechanical Equipment

Compressed Spruce Products Co., Inc., showed pulleys of various sizes and types made of Sprucolite. To make these, spruce fibres are pressed together to form a dense fibre structure and to eliminate moisture and are then worked into the proper shape and size with suitable cast-iron hubs pressed into them.

At the booth of The Garlock Packing Co. an interesting exhibit was shown consisting of a crosshead and a reciprocating shaft mounted with two new types of packing. The first of these was the Garlock-800 Varitemp metal packing for ammonia compressors, the other the new Garlock oil return wall plate metal packing for gas and air compressors, as recently described in these columns. Besides these was shown Garlock cord plugs for condenser tube cleaning and a new type of condenser tube packing formed in rings to any specified dimensions.

Ramsey Chain Co. had an interesting demonstration of a Ramsey chain hanging free from a sprocket driven at 6600 r.p.m. to show the form in which the chain hangs at this speed and the action of the improved compensating joint.

Strom Bearings Co. demonstrated a new type of bearing with a grease retaining shield, designed to be entirely dust proof and for use on wheels of industrial trucks. Besides this a new high speed ball bearing was shown, which was designed to run at 40,000 r.p.m.

Dodge Mfg. Corp. called attention to several new types of unit mountings for Dodge Timken bearings, also to a new steel take-up for its conveyor roller. There was also shown a new type of Dodge split steel conveyor pulley designed with oval crown, rim parting, supported directly from the hub and all hub and rim bolts easily accessible.

Durametallic Corp. called especial attention to the fact that a change has been made in its packing lubricant, the material now being a vegetable oil instead of a mineral oil. A new type of plastic packing, known as Magic Mud, was displayed, together with a new wedge type of metallic packing designed for all types of chemical pumps. It was also announced that Durametallic packing is now made in coil form and specimens of this were shown.

For cutting sheet metal of any description up to 18 U. S. gage, the new Mighty Midget Unishear was shown by the Unishear Co., Inc. This can be used as a hand tool or clamped to a bench as a stationary tool. It is designed to cut accurately at an average speed of about 15 ft. per min. on 18 gage iron.

The Mechanical Mfg. Co. exhibited the new Red Jack metallic packing designed for operation at pressures as high as 1200 lb. and temperatures up to 1200 deg. F. It is designed for application to all packing conditions, especially for centrifugal pump use. In another booth this company also showed the Thermal Unit, a new unit heater, the important feature of which is the integrally cast heating element of patented aluminum alloy, designed to achieve strength, freedom from leaks and correct air circulation.

Byllesby Engineering & Management Corp. showed scale models of the new Louisville, Ky., hydroelectric plant, the Bayside Steam plant at Green Bay, the Prospect No. 2 development, and a cross sectional model of one of the turbines in the Louisville hydroelectric plant.

John Crane metallic packing in new coil form was displayed in several types by Crane Packing Co.

Elcomet, an alloy designed for universal application in the chemical industry was demonstrated by The LaBour Co. at its booth. Another item of interest for use in chemical plants is the LaBour valve made of the new metal, Elcomet.

Several types of the new jet mixers for intimate mixing of fluids were displayed by the Fisher Governor Co. The cyclonic type No. 601 gives a whirling motion to one of the fluids, the other one being ejected into the vertex to produce mixture of the two. The type 603 and 604 differ from the Cyclonic mixer, because they operate on a syphon and injector principle.

Snap-On Wrench Co. called particular attention to its new Boxocket wrench with double hexagon or 12 point broachings, designed to use only half as much space for handle movement as end wrenches. This same type of double hexagon broaching has been adapted to new types of hexagon and square socket wrenches.

W. A. Jones Foundry & Machine Co. exhibited several specimens of its new line of heavy duty worm gear speed reducers. These are mounted on a cast iron base with motor and flexible couplings designed to preserve proper alinement of the unit.

Wm. F. Klemp Co. displayed its new Diamonos stair treads for boiler house and all industrial purposes. The front edge of this tread is constructed for great stiffness and also for high visibility. It is made to fit the requirements of each plant, the holes being punched for the stringers in each case.

At the booth of The Texas Co. an interesting display was given of the clearness of Texaco golden motor oil. A steam of this oil flowing over a weir fell in a wide sheet of oil to a basin below. Through the film of falling oil the company's name could be read very distinctly.

Celite Products Co. called attention to Celite, a new product designed to mix with concrete to increase workability and give better distribution of the aggregates and increased density.

Barco Mfg. Co. displayed a new joint for rubber and bakelite hot press work. This is a swivel joint to permit angular movement and a spring is used to provide for expansion and prevent leakage.

Irving Iron Works Co. showed a new application of the Irving continuous stream line flooring for armoring concrete or plastic floors for industrial purposes. A new joint in this armoring was developed from the streamline splice to prevent panels from upending.

The Timken Roller Bearing Co. showed a new type of double-row, self-contained Timken tapered roller bearing, designed especially for electric motors where there may be shaft expansion.

Chicago Rhopac Products Co. were featuring a new CO_2 packing, consisting of alternate fibre and metal rings. The fibre rings are built on a 35 deg. angle and the metal rings on a 45 deg. angle, with just sufficient metal allowed to support the fibre and hold it in place. Both rings are built in V shape and both the pressure from the glands and pressure from the inside of the cylinder tend to keep the packing tight around the shaft.

Applications of the Cooke seal ring to gasoline pumps, oil pumps, brine circulators were featured by the Cooke Seal Ring Co. They also demonstrated a large household refrigerating unit manufactured by the Cooke Electric Refrigerating Company, using Cooke seal rings to illustrate ammonia practice.

Applications and performance of the Wonder-Working machine for woodworking were demonstrated by the DeWalt Products Co. The machine is now fitted with adjustable guard and dust collector, new gages and rules and can be instantly changed from cross cut to rip. The head is marked in 5 deg. marks with a quick finding attachment at 90 and 45 deg.

In the booth of the Fafnir Bearing Co. an exhibit whereby a 1/40-hp. motor with string drive was driving 16 ball bearings and 8 shafts was featured to demonstrate the anti-friction bearings and the self locking collar and bearings and pillow blocks for plain shafts.

L-R flexible couplings, a new product, were featured by the Lovejoy Tool Works. This is a jaw coupling with loosely fitting rollers placed between the jaws. The coupling may be used for rotation in either direction.

LUBRICANTS, BOILER AND STEAM ACCESSORIES AND REFRACTORIES WERE SHOWN IN THESE BOOTHS

New dust collector on a disc grinder and the Syracuse oscillating vertical sander were featured by The Porter-Cable Machine Co. On the disc grinder fins on the under side of the disc act as a suction fan and collect the dust in a passage under the safety guard.

Low cold tests on oil were demonstrated by the Roxana Petroleum Corp. in a Dodge motor block entirely frosted over by means of a Frigidaire household unit. A crank case was cut away and glassed in to show the characteristics of the oil operating under these conditions.

Unusual and difficult applications of bearing metals were featured by Bearium Bearings, Inc., to demonstrate the non-scoring non-seizing qualities of its metal, which

will withstand temperatures up to 1200 deg. F. A new mixture known as B12 with an ultimate tensile strength of 35,000 lb. per sq. in. and a Brinnell hardness of 75 was shown.

In the booth of the Maplewood Machine Corp. a new type Gray No. 00 sheet metal cutter was demonstrated. This machine is built with a 30-in. throat for cutting sign letters, sheet metal templates and similar work from a scribed line.

Speed reducers of the worm and spur gear type were exhibited by the Albaugh-Dover Mfg. Co. who featured the units with a speed reduction ratio of 800,000 to 1.

Details of Diesel engine fuel oil injection pumps requiring precision work were displayed by the Ex-Cell-O Tool & Mfg. Co. These included plungers, bushings, suction valves, bypass valves, nozzle tips, etc. They also had on display their largest and smallest precision grinders.

Standard LiftAbout and close clearance hoist in actual operation were featured by the Shepard Electric Crane & Hoist Co. The close clearance hoist will turn on 3 ft. radius and the minimum distance from the hook to the I beam is 13.5 in.

One of the interesting features of the Show was the JFS variable speed transmission featured in the booth of the Stephens-Adamson Mfg. Co. This is a compact fully enclosed unit built in sizes to transmit from ½ to 18 hp. at the maximum reduction. It controls the speed by means of a hand wheel and occupies about the same space as a motor of the same size.

In the booth of the Commonwealth Edison Co. a comprehensive map of Illinois and Indiana shows in detail the super-power network, power lines and steam and hydro power stations of the Insull interests. The different systems were shown in various colors with points of interconnection indicated.

Public Service Co. of Northern Illinois featured by means of maps, pictures and statistics the industrial importance and advantages of the Chicago-Metropolitan district. In 1927 fifty-seven new industries, representing a payroll of $4,350,000 located in this territory.

Applications of the Rawlplug fibre screw anchor for glass, concrete and masonry work were shown in the booth of The Rawlplug Co. A 150-lb. block of concrete was suspended from a No. 14 screw 2.5 in. long and by means of a solenoid plunger was reversed at the rate of 7400 times per hour. A No. 6 screw set in a piece of plate glass was shown holding up a 107-lb. weight.

New and important improvements made in their transmissions were featured by the Reeves Pulley Co. The exhibit consisted entirely of new designs embodying improvements recently adopted.

Tendencies of bearings to act as pumps were demonstrated in an exhibit by the Standard Oil Co. A small motor shaft capable of being loaded by adjustable weights was lifting oil from a sump and discharging it through a sight feed. The flow of oil increasing as the load or bearing pressure increased.

Rapiduction double spindle bolt threading machines of a new type designed for speed and simplicity of operation were shown by Williams Tool Corp. These have 8 changes of spindle speeds which are controlled from a centralized control point on either side of the machine.

Developed Water Power Shows Increase

DEVELOPED water power in the United States on January 1, 1928, was 12,296,000 hp. showing an increase of 575,000 hp., or approximately 5 per cent, during 1927; and the total amount of potential water power available 90 per cent of the time is 38,110,000 hp. and that available 50 per cent of the time is 59,166,000 hp., according to an announcement by the Department of the Interior, through the Geological Survey. The figures for potential water power are not directly comparable with the figures for developed water power, because the figures for developed power are given in terms of the capacity of the installed water wheels, which may be several times the potential power available 90 per cent of the time. Estimates based on studies of the capacity of water wheels installed at fully developed water-power sites indicate that about 15 per cent of the potential water power of the United States is developed at the present time. If it were feasible to develop all the water-power resources of the United States, the total capacity of water wheels installed at all water-power plants would amount to about 85,000,000 hp.

All of the increase in developed water power in 1927 was in the plants of public-utility power companies, the capacity of water wheels in manufacturing plants showing a small decrease during the year. California still ranks first in developed water power, with a total of 1,993,000 hp. of water wheels in water-power plants. New York, with 1,779,000 hp., is second, and Washington, with 707,000 hp., is third. The rest of the ten leading water-power states are all east of the Mississippi River.

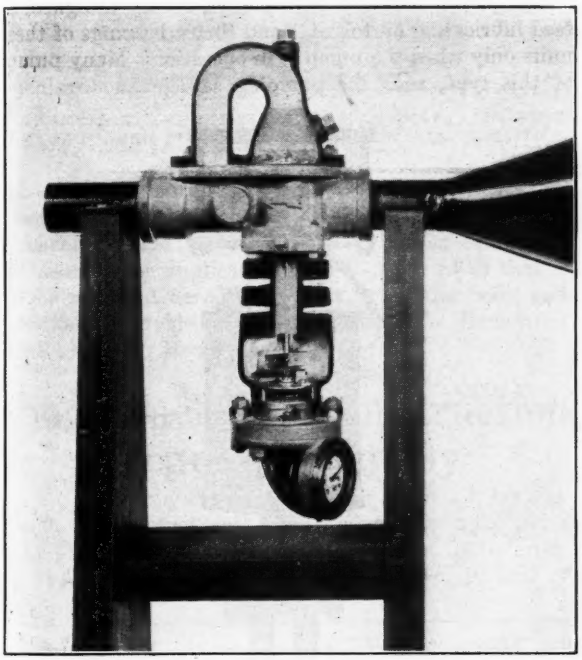
INTERNATIONAL COMBUSTION Engineering Corp., Ltd., is designing and building throughout, the new steam plant for the Synthetic Ammonia and Nitrates, Ltd., Stockton-on-Tees, England. This is expected to be the largest high pressure industrial plant in the world, according to The Engineer of London. Six boilers will be installed, of the vertical tube, rivetless and seamless type. They have each a maximum evaporation capacity of 269,000 lb. of steam per hour, at a total temperature of 840 deg. F., and are operated at 800 lb. per sq. in. The pulverized fuel plant will be constructed on the bin and feeder principle and the new type "R" high velocity burner recently developed by International Combustion, Ltd., will be employed to effect a reduction in the size of the combustion chamber. The coal will be handled in Raymond pulverizers, working on the closed system. The coal is dried by introducing hot air into the mill circuit itself, so as to obviate the use of separate dryers. The coal handling plant will have a daily handling capacity of 3800 t.

NEGOTIATIONS between the United Gas Improvement Co. of Philadelphia and the American Electric Power Corp. have resulted in transfer of the Sioux City (Iowa) Gas and Electric Co., including extensive Iowa holdings, to the Iowa Public Service Co. Involved in the transaction is the new $3,500,000 Big Sioux power plant at North Riverside for which a $1,000,000 addition is already under way.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

Shunt Steam Meter for Small Lines

FOR USE in small steam lines and designed especially for measuring steam flow, but equally suitable for air, the type KS Shunt steam meter shown herewith has recently been placed on the market in this country by



CROSS-SECTION OF SHUNT METER SHOWING TURBINE, DAMPING FAN, MAGNETIC DRIVE AND INDICATING DIAL

Builders Iron Foundry, Providence, R. I. The instrument, which was first brought out in England about five years ago by George Kent, Ltd., is made in 2, 3 and 4-in. sizes for pressures from 3 to 225 lb. gage, a high pressure type meter being used when the pressure exceeds 150 lb. or when the temperature exceeds 400 deg. F.

As steam enters the meter, a portion of it is deflected upward through nozzles and this portion actuates the small turbine mounted on the vertical shaft which is on a spring bearing to minimize the effect of any jarring that might be given the instrument. Near the lower end of this main shaft is mounted a damping fan, revolving in a chamber filled with condensate from steam. This arrangement is intended to keep the turbine speed low, to reduce bearing wear and to increase the range of the meter. The counter train at the bottom is driven through a permanent magnet, to eliminate the possibility of leakage into the counter chamber and to avoid stuffing box friction. The vertical counter dial can be turned to face in any desired direction and reads direct in total pounds of steam.

Since the entire equipment is a single unit, it can be bolted in the pipe line at any convenient location. It is furnished with flanged ends only and companion flanges can be supplied at a small extra charge. If the working range or conditions should be changed, the meter can be returned to the factory and adapted to the new conditions at slight expense. While the instrument is calibrated so that ordinary pressure fluctuations will not alter the total reading over a long period, correction factors for pressure variation are furnished for use in testing or under temporary change in working conditions.

The shunt meter is designed for low upkeep cost and low first cost and is guaranteed accurate within 2 per cent when operated at the pressure for which it is calibrated. It is also designed to handle overloads up to 50 per cent without damage and record them correctly. Capacities range from 2200 lb. saturated steam per hr. for the 2-in. meter at 3 lb. pressure to 27,600 lb. for the 4-in. meter at 225 lb. Bulletin No. 234 describing it will be sent by the company on request.

Improvements in Riley Super-Stoker

RECENT CHANGES in the construction of the Riley Super-Stoker, designed to make great improvements in its operation, make it entirely new inside the furnace,

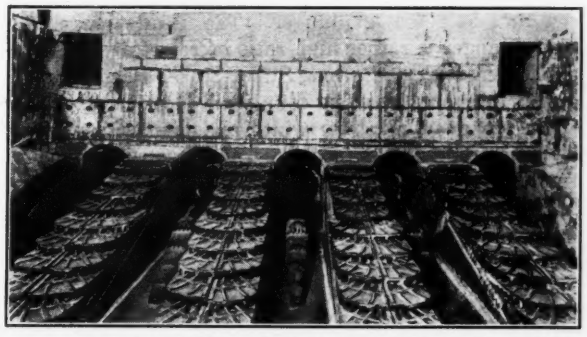


FIG. 1. FOUR GRATE BLOCKS AT FRONT ARE NARROWER THAN OTHERS TO INCREASE FLEXIBILITY AND CAPACITY WITH LARGE DIAMETER PLUNGER

according to Riley Stoker Corp., Worcester, Mass. The principal changes are illustrated herewith.

Each section of the stoker is provided with a damper

under the control of the operator so that he may supply more or less air, dependent on the fuel conditions at any particular point throughout the length of the stoker. These dampers are controlled from the side wall of the boiler.

In the front wall construction, means for admitting air over the top of the fuel bed has been provided. The amount of air so admitted is under the control of the operator. The control consists of a sliding damper, operated by a hand lever at the front of the stoker.

Another important improvement in the Super-Stoker over the old design is in the grate block construction. The length of the more recent multiple retort stokers demands a large coal feeding capacity. To obtain this

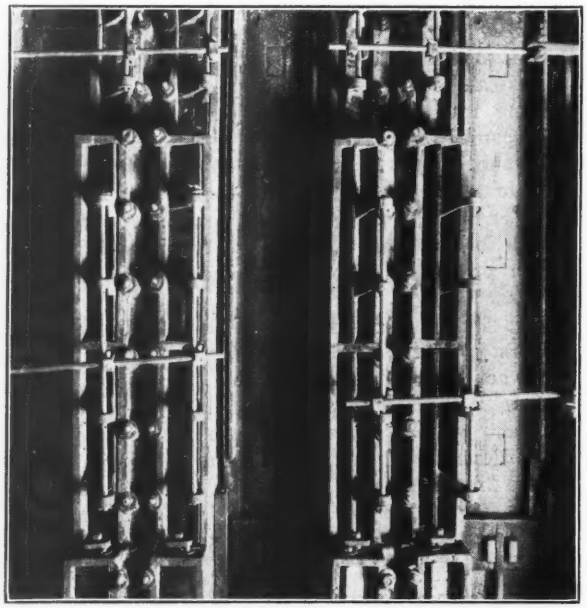


FIG. 2. LOOKING UP AT THE UNDERSIDE OF THE STOKER, ZONING DAMPERS ARE SEEN, OPERATED BY CONTROL RODS EXTENDING TO SIDES

capacity without undue wear of the moving parts, because of the high speed required if small diameter plungers are used, the Super-Stoker uses a large diameter and long stroke plunger. The disadvantage of a large plunger is rather high ratio of retort area to grate block area. With the new Super-Stoker this disadvantage is overcome by using four grate blocks at the front of the stoker of narrower width and then widening out the remaining grate blocks. This construction is intended to give higher capacity and greater pick-up and flexibility.

Clinker grinding operating mechanism has been redesigned to provide a more variable means of control. The drive for the double roll clinker grinder is arranged so that either or both rolls can be operated as desired. There is also a variable speed provision consisting of a cam which permits the driving pawl of the ratchet to engage one, two or three teeth as desired. Control for the ratchet pawl is independent for either grinder roll so that the speed of one roll can be varied independently of the other.

Figure 1, taken from the rear of the stoker looking at the front wall, shows the new type front wall construction and the new grate surface design. Figure 2, taken from the bottom of the air chamber, looking directly up at the under side of the stoker, shows clearly the zoning dampers and the operating rods extending to the side walls. Some of the dampers in the picture are closed entirely. Others are partially open and some are fully open.

Practically from the first it has been standard practice with multiple retort stokers to air zone the overfeed section. On the new Jones side dump stoker, dampers are also provided to accomplish this same result on the side dump type of stoker.

Oil Economizer Lubricates Only When Pump Runs

FOR AUTOMATICALLY controlled vertical shaft centrifugal pumps, the Yeomans automatic oil economizer shown herewith has been especially designed, to feed lubricating oil to guide and thrust bearings of these units only when the pump is in operation. Many pumps of this type, used for pumping sewage and drainage,

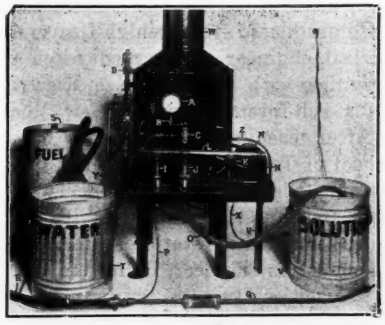
NEEDLE VALVE OF OIL ECONOMIZER IS OPENED OR CLOSED BY PUMP DISCHARGE PRESSURE

may be idle for long periods of reduced inflow, especially when they are reserve units arranged to cut in automatically under peak conditions only. It is obvious that if lubricant is continuously supplied to bearings in such cases, most of it will be wasted.

The oil economizer, as shown, consists of a multiplex lubricator of liberal capacity with individual sight feeds for all guide and thrust bearings requiring gravity lubrication. The needle valve in the oil container is automatically opened and closed by a diaphragm mounted on top of the lubricator and connected by copper tubing and piping to the pump discharge. The economizer is ordinarily mounted on a flanged pipe support on sump cover or base plate close to the motor. It is manufactured by Yeomans Brothers Co., 1433 Dayton St., Chicago, Ill., which has issued leaflet No. OE-10 describing it.

Hypressure Jenny

HYPRESSURE JENNY is the name given to the device shown in the illustration herewith, a new invention designed for a multiplicity of uses. The purpose of the apparatus is to generate steam at 150 lb. pressure and carry along with the steam a cleaning fluid. The steam generating unit, fired by fuel from the tank, is designed to raise steam to 150 lb. pressure



ARRANGEMENT OF HYPRESSURE JENNY, SHOWING TANKS HOLDING FUEL, WATER AND CLEANING SOLUTION

in 35 sec. The spray from its nozzle has been used for removing paint, cleaning grease and grime from surfaces of machinery and buildings, thawing frozen equipment and many other applications. It is designed so that it can be mounted on a small truck or rolling body and thus made portable. The manufacturer is Homestead Valve Mfg. Co., Homestead, Pa.

Long Beach No. 3 Construction Progresses Rapidly

AS SHOWN by the accompanying exterior view, Fig. 1, construction work is well advanced on the No. 3 plant that the Southern California Edison Co. is erecting at Long Beach, Calif., to house the No. 10 unit of

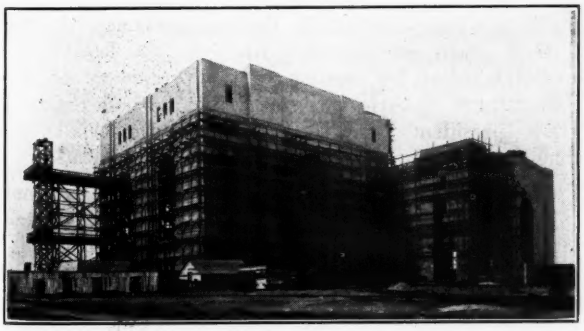


FIG. 1. FIRST SECTION OF NO. 3 PLANT AT LONG BEACH WILL CONTAIN ONE 94,000-KW. GENERATING UNIT AND THREE 3416-HP. BOILERS FIRED WITH NATURAL GAS AND FUEL OIL

94,000-kw. capacity. This is the first unit of the No. 3 plant, which is designed for an ultimate development of 8 units of 94,000 kw. each. It is located adjacent to the No. 1 and No. 2 plants of the company at Long Beach, previously described in these columns.

The new turbine will be supplied with steam at 400 lb. gage pressure, 725 deg. F. total temperature, by three water-tube boilers, each of 34,160 sq. ft. heating surface. These units are designed for 460 lb. pressure. The boiler room is laid out for four boilers. These will be fired with natural gas and fuel oil, with full provision made in the design for use of pulverized coal at a later date if desired. Furnaces are completely water-cooled by water tubes carrying refractory-faced blocks, the hopper bottoms of the furnaces being of the same construction. These furnace walls will be reinforced with steel trusses to withstand earthquake effects. Figure 2 shows one of the boilers in course of erection.

Power is stepped up to 60,000 and 220,000 v. for the transmission system, the transmission lines being carried across the Cerritos channel on two new sets of crossing towers. These are of structural steel, 310 ft. high, giving a clearance under the lines of 200 ft. at high tide.

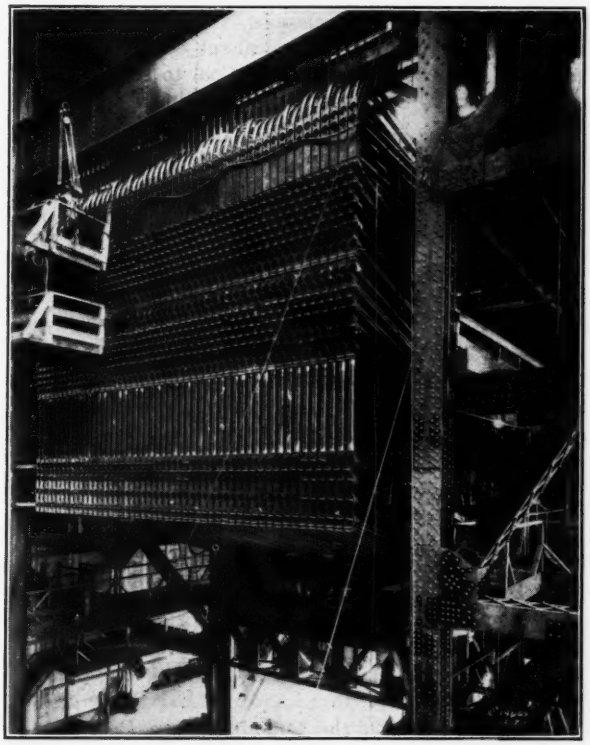


FIG. 2. ONE OF THE NEW BOILERS IN COURSE OF ERECTION

Design and construction of the new plant are being carried out by Stone & Webster, Inc., co-operating with the Department of Engineering Design of the Southern California Edison Co.

BENNINGS STATION of the Potomac Electric Co. at Washington, D. C., is to have a second 30,000-kw. turbine-generator unit to care for the steadily increasing load in this section of the country. The new unit, which is to be of General Electric manufacture, will be identical in rating and steam conditions with the present 30,000-kw. G.E. machine now in operation. The turbine will be of standard 17-stage design, operating at 350 lb. pressure, 700 deg. F., and 1½ in. back pressure. The generator will be rated 13,200 v., 60 cycles, 3 phase, 90 per cent power factor.

News Notes

FROM APRIL 5 TO 6, 1928, the Indiana Fuel Conference will be held at Purdue University, Lafayette, Ind., under the direction of the School of Mechanical Engineering and the Engineering Extension Department, with the School of Chemical Engineering co-operating. The program for the conference, which begins on Thursday, April 5, includes discussions of fuel resources of Indiana by W. N. Logan, State Geologist; Fuel and Power as Affecting Progress, by Dean A. A. Potter, Dean of Engineering; and Fuel Research Problems, by R. B. Moore, Dean, School of Science. At 6 p. m. on Thursday, at an informal dinner, A. D. Bailey, superintendent of power plants of the Commonwealth Edison Co., Chicago, will talk on Trend of Power Development. On Friday various papers will be given in the morning on Burning and Storing Indiana Coal, while in the afternoon discussions of Smoke Elimination, Merchandising and other technical subjects will be held, including a paper on Fitting the Coal to the Plant, by T. A. Marsh of Combustion Engineering Corp.

OTTO NONNENBRUCH, formerly Diesel test engineer for Blohm & Voss of Hamburg, Germany, and more recently assistant chief engineer of the Blake and Knowles Works of the Worthington Pump & Machinery Corp. in charge of the developments of the Blake and Knowles two-cycle, cross type, solid injection oil engine, has joined the staff of the De LaVergne Machine Co. of New York City.

BY UNANIMOUS VOTE, the American Engineering Council has elected A. W. Berresford to succeed Dean Kimball as president. Mr. Berresford has been engineer for the Ward-Leonard Electric Co., vice president and general manager of the Ironclad Resistance Co., the Cutler-Hammer Mfg. Co., and the Electric Refrigeration Corp. He was president of the A. I. E. E. in 1920 and was serving his second term as vice president of the A. E. C. when elected to the presidency. Major Gardner S. Williams of Ann Arbor, Mich., and I. E. Moultrop of Boston, Mass., were elected vice presidents. L. P. Alford of New York City was elected to the vice presidency to succeed Mr. Berresford. L. W. Wallace was re-elected treasurer.

ON FEBRUARY 23, the Detroit Edison Co. and the Consumers Power Co. were physically joined together when a switch was thrown at Jackson, Mich., officially putting into operation the new super-power connection between the two systems. At once 50,000 electrical horsepower became available to either company from the other through the connection.

ANNOUNCEMENT IS MADE that the Walsh Fire Clay Products Co. recently sold its central Missouri plants to Harbison-Walker Refractories Co. and will be known and operated under the latter title. The St. Louis plants of the Walsh Fire Clay Products Co. remain with their original owners, the Mississippi Glass Co., Glass Refractories Division, 4070 N. Main St., St. Louis, Mo.

AT THE ANNUAL MEETING of the officers and directors of the Orton Crane & Shovel Co., Chicago, Ill., recently held at Huntington, Ind., P. A. Orton, Sr., was re-elected president and general manager, Harry Shaffer was re-elected treasurer and P. A. Orton, Jr., was elected vice president and sales manager. Herbert Mertz was elected vice president in charge of sales in the New York territory. Alex Orton, works manager at Huntington, Ind.; C. C. Case of Chicago and J. L. Kenower of Huntington were elected members of the board of directors.

APPOINTMENT OF NEVIN ELWELL FUNK as chief engineer of the Philadelphia Electric Co., to succeed the late William C. L. Eglin, was announced on February 17 by William H. Taylor, president of the company. Since December 15, 1926, Mr. Funk has been assistant chief engineer. He graduated from Lehigh University in 1905 as an electrical engineer and served for a short time as an apprentice with Westinghouse Electric & Mfg. Co. and as a sub-foreman on the New York Central Railroad. After teaching for about nine months in the Georgia School of Technology, he entered the employ of the Philadelphia Electric Co. in 1907. Two years later he was made assistant superintendent in charge of operating, generating and substation systems, and in 1914 was made combustion engineer. Following this he served in various capacities, such as superintendent of the Schuylkill Station, operating engineer of the company and, in 1926 was made assistant chief engineer. He is a member of the A. S. M. E., A. I. E. E., N. E. L. A., and various other scientific organizations.

UNITED CONVEYOR CORP., Chicago, Ill., has purchased from Conveyors Corp. of America, the good will, patterns, patents, designs and manufacturing rights for the American Steam Jet Ash Conveyor, the American Cast Iron Storage Tank and American Air Tight Doors, and the Steam Jet Ash Conveyor business of its predecessors. These are American Steam Conveyor Corp., Green Engineering Co., Girtanner-Daviess Co., Griffin Engineering Co.

WILLIAM H. TAYLOR, vice president in charge of operations and maintenance of the United Gas Improvement Co., was elected president of the Philadelphia Electric Co. on February 14, succeeding Walter H. Johnson, resigned. Arthur W. Thompson, president of the United Gas Improvement Co., was elected chairman of the board. Mr. Johnson was elected assistant to the chairman, and Samuel T. Bodine, chairman of the U. G. I. board, was elected a director. Mr. Taylor, immediately after his election to the presidency of the Philadelphia Electric Co., stated that he had resigned as vice president of the U. G. I. Co. to devote his entire time to the business of the Philadelphia organization.

THE REITER CO., Elgin, Ill., manufacturer of external and internal deconcentrators for boilers, industrial water softeners and filters, as well as water softener chemicals, has doubled its capital and is preparing to expand its activities. Louis A. Fritze, vice president of the Paige & Jones Chemical Co., New York, has secured a large interest in the company, has been made secretary and general sales manager in charge of national sales promotion work.

RICHARD H. PASCALL, president of the Pickering Governor Co., died on February 6 in his 87th year. Mr. Pascall became associated with the Pickering Governor Co. in 1865, was made superintendent of the factory in 1875, and president in November, 1902. He was a member of the American Society of Mechanical Engineers and of various fraternal and scientific organizations.

Catalog Notes

THE WELLMAN-SEAVER-MORGAN CO., 7000 Central Ave., Cleveland, Ohio, in a 20-page bulletin, No. 89, illustrated in colors, describes the Wellman Supertest Gate and Globe Valves, a feature of which is the demountable cage arrangement.

EDGE MOOR IRON CO., Edge Moor, Del., in catalog No. 65, describes the Edge Moor cross drum boiler.

HARNISCHFEGER CORP., Milwaukee, Wisconsin, in Bulletin 639X describes P & H Truck cranes. In Bulletin GH-2 the P & H Groundhog, Model 300, is described and in Bulletin 650X P & H Model 206B Excavator Cranes.

THE BAYER CO., St. Louis, Mo., in a new 24-page illustrated bulletin, describes in detail the Bayer steam soot blower for boilers. In another 4-page folder it describes Chromite air-cooled soot blower elements.

CLARAGE FAN CO., Kalamazoo, Michigan, in catalog No. 42 describes Clarage unit heaters, made in several types and sizes to fit all industrial plant conditions.

PBH BOILER PANEL made by the Paul B. Huyette Co., 5 S. 18th St., Philadelphia, Pa., is described in a recent 4-page folder.

AMERICAN HOIST & DERRICK CO., St. Paul, Minn., in a 4-page leaflet describes the American Gopher Shovel Crane.

FOSTER SECTIONAL AIR HEATER is described in a 12-page bulletin, A.H.-7, just sent out by Foster Wheeler Corp., 165 Broadway, New York.

NATIONAL FLUE CLEANER CO., INC., Groveville, N. J., in a new 8-page bulletin describes the National soot blower for return tubular boilers.

BOILER ENGINEERING CO., 931 Federal Trust Bldg., Newark, N. J., is issuing a new bulletin describing the Beco Baffle Wall and its application to various types of boiler construction.

THE NEW STURTEVANT TYPE 14 auxiliary steam turbine with automatic nozzle control is completely described and illustrated in a recent bulletin issued by B. F. Sturtevant Co., Hyde Park, Boston, Mass.

DUST RECOVERY, INC., 15 Park Row, New York City, in bulletin No. 1, discusses the analysis of dust problems, selection of dust collecting equipment and methods of testing that equipment.

CUTLER-HAMMER MFG. CO., Milwaukee, Wisconsin, has just published a new booklet entitled "Magnetic Protection," describing the construction and use of all types of its magnetic separator pulleys.

PEABODY ENGINEERING CORP., 110 E. 42nd St., New York City, in a recent bulletin entitled "What's New in Firing Powdered Coal, Oil and Gas," describes the new Toronto powdered coal burner, the Peabody insulated burner front and other new equipment.

RILEY STOKER CORP., Worcester, Mass., discusses Combustion Equipment for the office building, apartment house, hotel and school in an attractively illustrated 24-page booklet. A 4-page folder has also been issued describing the Riley flare type burner for pulverized coal. The company has also begun the publication of a magazine entitled "The Firing Aisle." This shows cross sections and photographs of installations of its equipment in well known power stations.

WHITING CORP., Harvey, Ill., in its new Crane Catalog, No. 209, a 72-page, well illustrated book, superseding No. 200, describes and illustrates Whiting cranes. Methods of manufacture of the cranes and methods of applying them are shown, also details of construction and tables of dimensions for designers.

UNITED FILTERS CORP., Hazleton, Pa., in a six-page bulletin describes the Kelly Pressure Filter, type O.R., for reconditioning engine oils, which is being adapted to use with Diesel and other internal combustion engines to recondition crank case oil.

THE DUST RECOVERING & CONVEYING CO., Harvard Ave. and 116th St., Cleveland, Ohio, in Bulletin No. 517, publishes an article by L. M. Schlabach telling how pneumatic conveyors help to solve the raw material handling problem.

ANDALE ENGINEERING CO., Philadelphia, Pa., in a recent folder describes the new Type 202 Andale oil cooler, designed so that the head can be removed without breaking pipe joints.

AMERICAN BLOWER CO., Detroit, Michigan, in a recent bulletin, No. 3504, superseding No. 2004, describes the type SE steel plate blower.

THE BRISTOL CO., Waterbury, Conn., in catalog No. 1502, just issued, describes Bristol recording wattmeters, recording frequency meters and other electrical instruments and accessories.

COCHRANE CORP., 17th St. and Allegheny Ave., Philadelphia, Pa., in bulletin No. 675, describes and illustrates domestic deaerators for heating systems, industrial plants, etc.

BAYLEY BLOWER CO., 732 Greenbush St., Milwaukee, Wis., in a 34-page well-illustrated booklet, No. 32, describes Bayley Aerovane Blowers, giving tabulations, sizes, capacities and dimensioned sketches of the units.

IN VOLUME 1, No. 6, of the Adsco Advocate, published by the American District Steam Co., North Tonawanda, N. Y., is an article on district heating as a by-product of industry; another on the engineer in district heating development and a third discussing district heating for colleges and other building groups.

SCHUTTE & KOERTING CO., Philadelphia, Pa., has just issued bulletin No. 17-A describing spur and herringbone gear pumps designed for handling oil, water, chemicals or liquids.

DETROIT STOKER CO., General Motors Bldg., Detroit, Mich., in two new bulletins, describes the Detroit Uni-Stoker and the Detroit underfeed stoker.

WESTINGHOUSE ELECTRIC & MFG. CO., E. Pittsburgh, Pa., in a 4-page folder illustrates and describes the new turbo-gearbox drive, including coal feed indicator, for Westinghouse multiple retort underfeed stokers.

BRISTOL CO., Waterbury, Conn., in a 4-page folder, describes the new model of Bristol's Recording Thermometer made in a smaller size than usual to take a 4-in. chart.

Power Plant Construction News

Ala., Decatur—The Mason Brown Ice & Coal Co., Huntsville, Ala., has purchased property on Moulton Street, Decatur, and is considering the construction of a one-story electric-operated ice-manufacturing plant, estimated to cost $65,000 with equipment.

Ark., Pine Bluff—The Independent Ice Co., Fourth Avenue, has begun an expansion and improvement program to cost about $30,000, including installation of additional equipment.

Calif., Sacramento—The Sacramento Pulp & Paper Co., 3245 Tenth Street, plans the construction of a boiler house at its proposed mill on the Sacramento River, near the city. Entire project will cost close to $500,000. C. A. Kieren, Portland, Ore., is engineer.

Del., Milton—The Milton Canning Co. will install power equipment in connection with proposed rebuilding of its factory destroyed by fire, Feb. 19, with loss estimated in excess of $200,000, with machinery. Edgar Nichols is manager.

Ill., Chicago—The Produce Terminal Cold Storage Co., care of Henschien & McLaren, 1637 Prairie Avenue, architects, has asked bids on general contract for its proposed ten-story and basement cold storage and refrigerating terminal building, 160 by 280 ft., at Throop Street and Fifteenth Place, estimated to cost in excess of $1,500,000 with equipment.

Ill., East St. Louis—The American Zinc, Lead & Smelting Co., 331 Madison Avenue, New York, plans the installation of power equipment in connection with proposed additions to its local plant. The entire program will cost close to $500,000.

Ill., Rockford—The Sanitary District Board, 118 South Main Street, G. J. Boehland, president, is reported considering a new pumping station in the Highland district, estimated to cost $25,000.

Ind., Laporte—The Metal Door & Trim Co., Laporte, plans the installation of power equipment in connection with proposed rebuilding of its plant recently destroyed by fire with loss of about $100,000.

Kans., Sterling—The Common Council is having plans completed for extensions and improvements in the municipal power plant, including installation of additional equipment, and will soon ask bids. The Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., is engineer.

Ky., Glasgow—The Glasgow Oil Refining Co. will install power equipment in connection with proposed rebuilding of its plant recently destroyed by fire with loss of about $30,000.

La., Shreveport—The Shreveport Producing and Refining Corporation, Commercial National Bank Building, will make extensions in its gasoline plant, with enlargement of boiler house and installation of additional equipment. Entire project will cost in excess of $200,000. Contracts for a portion of equipment have been let and other awards will soon be made.

Mich., Ann Arbor—The Board of Trustees, University of Michigan, is planning extensions and improvements in its power plant to cost about $100,000; an appropriation has been asked.

Minn., Newport—The Cudahy Packing Co., Newport, meat packer, will soon begin the construction of a five-story cold storage and refrigerating plant, 115 by 132 ft., reported to cost in excess of $100,000.

Mo., Anglum—B. F. Mahoney & Co., care of McDonald & Condie, Field Building, St. Louis, Mo., architects, will build a one-story power house in connection with its proposed local airplane manufacturing plant. Bids will soon be asked.

Mo., Kansas City—The Sheffield Steel Corporation plans the installation of power equipment in connection with extensions in its plant, estimated to cost more than $2,500,000 with machinery.

N. C., Reidsville—The American Tobacco Co., 111 Fifth Avenue, New York, contemplates the installation of a steam power plant in connection with a new factory, drying and curing plant at Reidsville. The entire project is reported to cost more than $500,000.

N. D., Langdon—The Otter Tail Power Co., Fergus Falls, Minn., will make extensions and improvements in its local power plant, including the installation of new equipment. Work will begin at once.

N. J., Trenton—The John A. Roebling's Sons Co., Roebling district, plans the installation of power equipment in connection with a proposed new rod and steel mill addition at its cable and wire works. The entire project will cost about $700,000.

Ohio, Cleveland—The Grasselli Chemical Co., Guardian Building, is said to have plans nearing completion for a one-story power house, 40 by 60 ft., at its plant on the Independence Road.

Ohio, Toledo—The Willys-Overland Co. plans the installation of power equipment in connection with proposed additions to its automobile manufacturing plant. The entire project will cost in excess of $500,000.

Okla., Oklahoma City—The Oklahoma Gas & Electric Co., Oklahoma City, is reported planning the construction of four steam-operated electric power plants at Healdton, Lexington, Meeker and near Wynnewood, respectively, for use in connection with pipe line projects of the Shell Pipe Line Co. Estimates of cost will soon be made.

Pa., Philadelphia—The Kensington Shipyard & Dry Dock Co., Beach and Palmer Streets, Francis J. McDonald, president, will install power equipment in connection with proposed extensions and improvements at its plant, formerly the shipyard of the William Cramp & Sons Ship & Engine Building Co. Entire project will cost close to $500,000.

Pa., Phoenixville—The Phoenixville Hosiery Co. plans the construction of a one-story boiler plant, 24 by 44 ft., in connection with a new mill. Clarence E. Wunder, 1520 Locust Street, Philadelphia, Pa., is architect.

S. C., Greenwood—The Savannah River Electric Co., operated by the Southeastern Power & Light Co., Birmingham, Ala., is said to be perfecting plans for a hydroelectric power project on the Savannah River near Greenwood, for which Federal permission recently was secured, reported to cost close to $20,000,000 with transmission lines.

Tenn., Nashville—The Peter Fox Sons Co., 1122 Fulton Market, Chicago, Ill., food products, is reported planning the construction of a new multi-story ice-manufacturing and cold storage plant on First Avenue, Nashville, to cost in excess of $300,000, with equipment.

Tenn., Nashville—The Nashville Railway & Light Co. is arranging an expansion and improvement program to cost about $750,000 during 1928, including transmission lines, substation extensions, etc. J. P. W. Brown is vice president and general manager.

Tenn., Sparta—The Sparta Electric Light & Power Co., care of Dr. W. B. Young, Sparta, recently organized, is planning the erection of a steam-operated electric power plant for local commercial service.

Texas, Pampa—Godfrey L. Cabot, Inc., 940 Old South Building, is considering the construction of a new producing plant in this vicinity, to be equipped for a capacity of 30,000 pounds of carbon black daily. Installation will include compressors, boiler and power equipment, handling apparatus, etc., with entire project to cost close to $500,000.

Utah, Salt Lake City—The Utah Woolen Mills Blanket Co. plans the installation of power equipment in connection with a new mill estimated to cost $160,000. Ashton & Evans, Vermont Building, are architects.

Va., Suffolk—The planters' Nut & Chocolate Co., 212 Johnson Avenue, plans the installation of power equipment in a proposed seven-story addition to cost in excess of $350,000.

Wash., Forks—Ward McMahan, Port Angeles, Wash., and associates have plans under way for the installation of an electric light and power plant for commercial service at this place. A Diesel engine unit will be used. Project will include a transmission line. Permission has been secured.

Wis., Waukesha—The Glancy Malleable Iron Corporation, 840 Wisconsin Street, plans the installation of power equipment in connection with proposed extensions estimated to cost close to $200,000. A. R. Glancy is president.

Wyo., Evanston—The Utah Power & Light Co., Salt Lake City, Utah, plans the construction of a transmission line from Echo to Evanston, Wyo. Surveys will be placed under way at once.